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TRACTS

WRITTEN

By the Honourable

ROBERT BOYLE.

About
- *The Cosmicall Qualities of things.*
- *Cosmicall Suspitions.*
- *The Temperature of the Subterraneall Regions.*
- *The Temperature of the Submarine Regions.*
- *The Bottom of the Sea.*

To which is Præfixt,

An Introduction to the History of Particular

QUALITIES.

OXFORD,

Printed by *W. H.* for *Ric. Davis.*

M. DC. LXXI.

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An Advertisement of the Publisher to the *READER*.

THough the Noble Author of the following Tracts hath also written divers other short Discourses, upon several occasions, yet, had he not been diverted from his purpose, he had continued to let them ly by him, intending, in case he should suffer them to come abroad, to dispose of them agreeably to a Design, that 'tis not necessary the Reader should be now acquainted with.

In the mean while, severall Virtuosi, to whom some of these Tracts had been shewn, and with whom the matters handled in some others had been discoursed, did out of a concerne, (as they gave out,) for the Common-wealth of Learning, pressingly represent to the Author;

First, that divers of these Loos Tracts, having little or no dependency upon one another; might without Inconvenience be published apart, in what Number and Order the Author should please.

Secondly, that since his main Designe in these as well as his other Physicall Writings, was to provide Materialls for the History of Nature, it would be thought enough, that they be substantiall and fit for the Work; in what order or Association soever they should happen to be brought into the Philosophicall Repository.

Thirdly, that the Communicating these Tracts to the curious, would be the best way to secure them from being lost or imbezelled, as some others of his Papers have been not only formerly, but very lately.

Fourthly, that the kind Reception, the Curious had given to what he had hitherto presented them, might well invite, if it did not oblige him, not to envy them the early use

of

of those Experiments and Hints, which will probably, before the time wherein his design would suffer them to come abroad, prove serviceable to Philosophy, by setting divers inquisitive heads on Work, exciting the Curiosity of some, and exercising the Industry of others.

Lastly, that, as of the Peices, he had hitherto published (except where his owne Backwardnesse had expressedly interposed) the first Edition had not long been the only; so probably within a moderate space of time, another Edition of those Tracts, he should first put out, would both allow him to increase their number, & change their order as he should judge most expedient, &, (in case he should in the mean while returne to his Library,) recruit his Discourses with those Passages, that he designed to borrow for them thence.

But, though these considerationss, joyned to the earnestnesse of the Persons that made them, and the just respect he had for them rendered it uneasy for him to resist their perswasions; yet they never obtained an actuall compliance till they were assisted by such an unhappy juncture of sickness and businesse, as, leaving him small hopes of accomplishing his first intentions in any reasonable time, made him consent to send away to the Press some of those Tracts, that he found the least unready for it, in the order wherein they chanced to come to his hands. Which being thus represented the considering and Ingenious Reader will soon find, what cause there is, and how much it concerns the Advancement of Valuable Philosophy, that, since this excellent Author hath (to the publisher's knowledge, as also was insinuated above) many other rare Tracts of a Philosophicall nature in store, he be solicited from time to time, that he would be pleased, according to the measure of health he shall enjoy to impart with all possible speed those Discourses, which tend to the enlargement and progresse of usefull knowledge, maugre all Envy and Malice.

H. O.

OF THE

SYSTEMATICALL

OR

COSMICALL

QUALITIES

OF THINGS.

NOVEMB. 3. 1669.

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P. MEWS

Vice-Can. OXON.

OF THE Systematicall or Cosmicall *QUALITIES of things.*

CHAP. I.

I Expect, *Pyrophilus*, that being somewhat surprised at the Title of this Discourse, you will presently ask what I understand by *Cosmicall or Systematicall Qualities*; that name being new enough to require, that I should tell you, both what I mean by it, and why I make choise of it.

To answer so reasonable a Question, I shall informe you, that I consider, that the Qualities of particular Bodies (for I speake not here of Magnitnde, Shape, and Motion, which are the Primitive Moods and Catholick Affections of Matter it self) do, for the most part consist in Relations, upon whose account one Body is fitted to act upon others, or disposed to be acted on by them, and receive Impressions from them; as *Quicksilver* has a *Quality* or Power (for I here take *Qualities* in the larger sense) to dissolve Gold and Silver, and a Capacity or Disposition to be dissolved by

by *Aqua fortis*, and (though lesse readily) by *Aqua Regis*. And this being premised, I observe farther, that, though in estimating the Qualities of Naturall Bodies we are wont to consider but the power any particular one has of acting upon, or the capacity it has of suffering from such and such particular Bodies, wherewith tis taken notice of to have manifest Commerce in point of makeing or of receiveing Impressions; yet there may be some Attributes, which may belong to a particular Body, and divers alterations to which it may be liable, not barely upon the score of these Qualities that are presumed to be evidently inherent in it, nor of the respects it has to those other particular Bodies to which it seems to be manifestly related, but upon the account of a Systeme so constituted as our World is, whose Fabrick is such, that there may be divers vnheeded Agents, which, by unperceived meanes, may have great Operations upon the Bodie we consider, and work such changes it, and enable it to work such changes on other Bodies, as are rather to be ascribed to some unheeded Agents, than to those other Bodies, with which the Body propos'd is taken notice of to have to doe. So that although if divers Bodies that I could name were placed together *in vacuo*, or removed together into some of those imaginary spaces, which divers of the Schoolmen fancie to be beyond the Bounds of our Vniverse, they would retaine *many* of the Qualities they are now endowed with; yet they would not

not have them All: but by being restored to their former places in this World, would regain a new *Set* of Faculties (or Powers) and Dispositions, which because they depend upon some unheeded Relations and Impressions, which these Bodies owe to the determinate Fabrick of the grand Systeme or World they are parts of, I have, till I can find a more proper Appellation, thought fit to name their *Cosmicall* or their *Systematicall Qualities*.

I have in the *Origine of Formes* touched upon this subject already, but otherwise then I am now about to doe. For whereas that which I doe *there* principally, (and yet but Transiently,) take notice of, is *That one Body being surrounded with other Bodies, is manifestly wrought on by many of those among whome 'tis placed*: that which I cheifly in *This Discourse* consider is, the Impressions that a Body may receive, or the power it may acquire, from those vulgarly unknown, or at least vnheeded Agents, by which it is thus affected, not only upon the account of its owne peculiar Texture or Disposition, but by vertue of the generall Fabrick of the World.

CHAP. II.

NOw though there be severall of the grand mundane Bodies, & divers Laws & customs of Nature which may contribute (more or lesse) to

to the *Phænomena* of the *Qualities* we are treating of; yet because a distinct and particular Inquiry into each of them would challenge a much longer Discourse then this short Essay is to be, and a much abler pen then His that writes it; I did not onely think it fit to reserve what occurs to me about the Laws and Customs of Nature, as they concerne this *Subject*, to another Discourse, or an Appendix to this; but to declare to you also, That whereas the three main Bodies whose more unobserved Operations and Changes have the most considerable Influence on the Qualities we are to treat of, are, the subterraneal Parts of the Globe we inhabit, the Stars, whether Fixt or wandring, with the Æther that is about them; & the Atmosphere or Air we live in; I foresee that 'twill be requisite for me to assigne the Experiments and Observations I have collected about these three Subjects to other Tracts. So that in this Essay my cheife work will be, to take notice to you of some Considerations that may be Introductory in a more generall way to the clearer knowledge of the Subject to be discoursed of. To which I may, as time and my occasions may permit, subjoyn some Particulars, which though perhaps they doe not all of them so directly or properly belong to the solemnly propos'd Heads of this discourse, yet are not impertinent to the Designe of it; and on that score may be allowed their places in it.

And least you should think that under the name

of

of *Cosmicall* Qualities I should introduce Chimæras into naturall Philosophy, I must betimes advertise you, that you will meet with divers Particulars in the following Discourse, fit to shew that these Qualities are not meerly fictitious Qualities: but such, whose Existence I can manifest, not only by considerations not absurd, but also by real Experiments and Physicall *Phænomena*. And to prevent mistakes I shall adde, that under the name of Catholick and unminded Causes or Agents, I comprehend not only divers inviſible Portions of Matter, but also the Establisht Lawes of the Universe, or that which is commonly called the *Ordinary Course of Nature*. And when I speak of unobserved Agents or Causes, I do not alwaies mean, that they are not known or taken notice of to be *in Rerum natura*, but that they are not vulgarly considered or lookt upon, as the Causes of some Particular *Phænomena*, wherein I ascribe to them an Interest or Efficiency.

But before I proceed any farther, 'twill not be amisse to intimate in this place, that the things, on which I founded the proposed notion of the Cosmicall Attributes of Bodies, were principally these three;

1. That there are many Bodies, that in divers cases act not, unles they be acted on, & some of them act, either solely or cheifly as they are acted on by the Catholick and unheeded Agents, we have been speaking of.

2. That there are certain subtle Bodies in the world, that are ready to insinuate themselves into the Pores of any Body disposed to admit their action, or by some other way affect it, especially if they have the Concurrence of other unobserved Causes and the establisht lawes of the Universe.

3. That a Body by a mechanicall Change of Texture may acquire or loose a fitnesse to be wrought upon by such unheeded Agents, and also to diversify their operations on it upon the score of its varying Texture.

These three Propositions I shall endeavour to confirm distinctly by the ensueing Experiments & *Phænomena*, but because divers of these prooses may each of them serve to confirm more than one of these Propositions, and because the makeing out of the two last, which are the most important (and the least probable) is the main Designe of this Discourse, I shall say the lesse to the first, leaveing It for the most part to you, to referr to either of the three Propositions, what you shall meet with belonging to it in what is said upon either of the other two.

CHAP. III.

To begin then with the first Proposition namely. *That there are many Bodies, that in divers cases act not unlesse they be acted on, and some of them act either solely or Cheifly as they are acted on by*

by the Catholick and unheeded Agents, we have been speaking of: the *former* part of it will, I presume, be easily granted, it being evident by such grosse Instances as these, that a Wedge will not cleave a Blocke unlesse it be impelled against it by a Hammer (or some Æquivalent Instrument) nor a Knife attract a Needle, unles it be excited by a Magner. But as to the *second* it will not *in* likelyhood be so readily assented to, and therefore having in *transitu* illustrated it by observing to you, that Concave looking Glasses and Convex burning Glasses, kindle not other Bodies, unlesse they be enabled to do so by the reflected or trajected Beames of the Sun, I shall proceed to prove it by a couple of instances.

The one is, That of an Iron Barr, that hath long stood in a Window, or some other fit place in a perpendicular Posture; for though this Barr was not when it was first erected, endowed with a Magnetisme any thing superior to that of other Iron Barrs of the like shape and bigness, yet after it hath very long stood in that position, it will by the operations of invisible Agents acquire a farther Degree of Magnetism, than belonged to it, as a Bar of Iron, and is enabled to produce some Magneticall *Phænomena* (elsewhere mentioned) that it could not before.

The second instance is afforded us by what happens to a very flat & exquisitely polisht piece of Marble; for though of it selfe it hath no power to help to lift up any other dry Body that tis

laid upon, yet if it come to be skillfully laid upon another piece of Marble as flat and smooth as it, and of a bulk not too unwildy, this upper stone, by Vertue of the Fabrick of the World, which gives the ambient Air Fluidity and Weight, is enabled without any other Cement or fastening Instrument than immediate Contact, to raise with it selfe (in case a man lift it up) the lower Marble, though perhaps an hundred times heavier than it selfe. * [Whereas if this laying one of these stones upon the other had been done *in Vacuo*, I doubt not but no such power had thereby accrued to the uppermost of them.]

* See this Experimentally proved in the continuation of the Authors new Experiments touching the Air, Experiment the Fiftieth.

CHAP. IIII.

PRoceed we now to our second Proposition, which speakes to this purpose, *That there are certain subtle Bodies in the World, that are ready either to insinuate themselves into the Pores of any Body, disposed to admit their Action; or by some other way to affect it; especially if they have the Concurrence of other unobserved Causes, and the establisht Lawes of the Universe:* I need not take notice on this occasion, that divers of the Ancient Philosophers thought, that there was a subtler Body than the common Air, and called *Æther*, and that the

Cartesians

Cartesians tell us, that there is such a substance diffused thorowout the Universe, which they call according to the differing sizes of its parts sometimes *Primum Elementum*, and sometimes *Materia Cœlestis*, to which they attribute the use of pervading all other Bodies, and adequately filling those Pores of theirs, that are correspondent in Bigness and Figure to the differing Portions of this Insinuating Matter. That there may be such a substance in the Universe, the Asserters of it will probably bring for proofes severall of there *Phænomena* I am about to relate. But whether there be or be not in the world any Matter, that exactly answers to the Descriptions they make of their first and second Elements, I shall not here discusse; though divers Experiments seem to argue, that there is in the world an Æthereal substance very subtle and not a little diffused: but though these things seem, as I was saying, probable enough; yet the invisible Agents, I shall here cheifly, though not only, take notice of, will be the Air (as it hath a Weight and Spring) and the magneticall Effluvia of the Terrestriall Globe.

If you take a Barr of Iron or rather of Steel, and another like it of Silver, and having heated each of them red hot, and put them to cool directly North and South, though they be both acted upon by the same Agent, the Fire, and the Steel, as to sence, seems such as it was before, yet the Texture of these two Metals being different, the Silver acquires no new Quality by what hath

been done to it, whereas the Ignition of the Steel having opened its Pores, and made its parts more pliable (as may be argued from the Swelling of Iron heated red hot, and its softnesse under the Hammer) it is easily, whilst in this state it lies North and South, pervaded by the Magneticall effluvia of the Earth, which glide perpetually through the Air from one pole to another, and by the passage of these steames it becomes endowed with a magneticall Property, which some call Polarity, whereby being freely suspended and exactly poised it will as it were, spontaneously direct it selfe towards the North and South, and exercise some operations peculiar to Magnetical Bodies. And that it may seem the lesse strange, that I should ascribe to so grosse and dull a Body, as the Earth, the Power of invisibly communicateing to Iron a magneticall Vertue, which is thought to be of so spirituall a Nature, I shall put you in mind of an Experiment, that I acquainted you with divers years agoe, about the Earths Power to impart, in some cases without the help of a Loadstone, a directive faculty to the Loadstone it self. For, having by Ignition deprived an oblong Magnet of its former attractive Power, by taking it red hot out of the Fire, and suffering it to cool North and South, I could at pleasure, by placing either end Northward or Southward, whilst the Stone was refrigerating, make what end I had a mind to, point to the North Pole; and when it had done so, I could, by a new Ignition

tion and refrigerating of it in a contrary position, make the same end of the Stone become its Southern Pole.

If you take a capacious glasse Vial with a slender neck, ending in a sharpe Angle with only a Pin hole left open at the Apex, (instead of which Vessell, *Hero's* Egg, as some call it, though far smaller, and without such a neck may serve turn) and by suction or otherwise free it from as much of the included Air as you can, and if then haveing stopt this Hole with your Finger, you immerse it somewhat deep under water, and (lastly) withdraw your Finger; the Water will, contrary to its owne Nature (as is vulgarly conceived) spring up with violence, and to a good height into the Cavity of the Viall; which motion of a heavy Liquor upwards cannot be ascribed to the motion of the Finger; for That did but unstop the Orifice, and not impell up the Water; nor need be attributed to Natures abhorrence of a Vacuum, which (whether there be such a thing or not) 'tis altogether unnecessary to have recourse to in this case: the Pressure of the Ambient Air, proceeding from its Weight upon the surface of the Water being sufficient to force up that Liquor into the Viall, in which the remaining Air by being rarified, upon the score of the Absence of that which was taken out, hath it spring too much weakned to be able to resist the Pressure of the outward Air, as it formerly could doe; whereas if this Experiment were try-

ed in Vacuo; the Water would not be raised, there being no outward Agent to impell it up.

CHAP. V.

I Had sometimes the Curiosity to consider Beans & Pease pull'd up out of the Ground by the Stalks, in order to an enquiry into their Germination, and after having taken Notice of their Tumidnesse upon their having imbib'd the moisture of the Soil, and of their way through the Ambient Earth not only upwards with their Stems but downwards with their tender Rootes; I thought fit to try with what strength or force the causes of their Intumescence endeavoured to dilate them. Whereupon I filled with a Quantity of such dry Beanes, as are in England wont to be given to Horses, severall Vials and Bottles, some of Glasse, and some of Earth, whereof two or three were of a very considerable strength: which done, the Intervalls between the Beanes were filled with water, and the Vessels were exactly stopt with Corkes strongly tyed down with Strings, that nothing might get out; for I supposed that the water soking into the Pores of the Beans would alter the Figure of the Pores, & produce in them an endeavour to swell; which being checkt by the Sides and Stopples of the Vessels would discover, whether that endeavour were so

so forcible as I suspected. The Successe was, that most of these Vessels (for in one or two of them we found the strings broke that withstood the raising of the Stopples) whether of Glasse or Earth, were burst in sunder.

But being desirous to make a nearer Estimate, how great this Expansive force of the swelling Beanes was, we put a convenient quantity of them into an hollow, but strong Cylinder of Brasse, which I had caused to be purposedly made for such kind of Tryalls, whose Cylindricall Cavity was just six Inches in lenght, and two in Diameter; then having put in Water enough to reach the top of the Beanes, we put into the upper part of the Cylinder, which was purposedly left unfild, a wooden plugg made fit for the orifice, by being turned into a Cylindricall Form, and a little narrower than the orifice, that it might move freely up and down, though the Water should make it somewhat swell. Upon the Top of this Plugg, on which leaned a broad and thick peice of wood shaped like a round Trencher, and made of the same peice with the Plugg, was placed a common half hundred weight of Lead, which yet could not depresse the Plugg too low, being hindred by the breadth of the Trencher, made as well to prevent the too great Depression of the Plugg, as to afford a convenient Basis to the Weight. Lastly; having kept the Cylinder in a quiet place for a fit space of time (which is in such tryalls sometimes 2

or

or 3 daies sometimes more or lesse according to the Temperature of the Air, and Quantity of the included Matter,) we observed, as I expected, that the swelling Beanes had very Manifestly heaved up the Plugg, and the incumbent Weight beyond the former Station. And I suspected that if we had had small Weights (of a pound or two a peice) conveniently shaped, a heavier weight might have been raised by the same force.

It is not necessary in this place, that I mention severall Particulars relating to the experiment, as how it succeeds in Corn ground and unground, how in dryed Fruits, as Raisins and Currants, how in dry'd pease (which we found to dilate themselves very strongly) and what Liquors will or will not cause an Intumescence; nor shall I here speak of divers Circumstances, that may be taken notice of in such Tryalls; only I must not omit this particular, that I had a mind to make some Tryall, Whether the force of swelling Beanes to presse or thrust up the incumbent Weight would not in Cylinders of different sizes be encreased in somewhat near a duplicate proportion to that of the Diameters, or the Areas of the Orifices of the differing Cylinders (because 'tis according to the greatnesse of those Areas, that the force can be applied upwards;) but having not weights enough so shaped as I needed, I could not make such an experiment as I desired; but thus much however I discovered in order to my Purpose that the Pressure upwards of the drench'd Beanes

Beanes, was very much greater in wider Cylindricall Vessels than in narrower ones: for having put a convenient Quantity of dry'd Beanes into a Metalline Cylinder that wanted a pretty deal of being so deep as six Inches, and was not quite four Inches broad; when the included Beanes began to swell, they manifestly lifted up such a Plugg as was lately describ'd (but broader) with weights upon it, amounting to an hundred pound or better.

Whether this may passe for a new (Physicall) *vis movens*, I freely leave to you to determine, as also to consider, whether by Mechanicall Contrivances so great a Force, as may be this way produced, and which slowly and silently proceeds till it hath attained its utmost Energy, and may be conveied into Bodies without working any Effect before the due time; may not in some cases be made applicable to usefull purposes.

I shall not now examine, whether or how far the foregoing Experiment may confirme the *Cartesian Hypothesis* about their *materia Subtilis*, nor whether upon the notions which our Experiment may suggest, wee may be enabled to explicate the Force, wherewith fermenting Liquors doe often break the Vessels, wherein they are too exactly shut up; about which *Phænomena* and of some others of kin to it, I elsewhere propose some Conjectures.

I think it fitter in this place to take notice to you of something, that more directly belongs, to

our

our present Subject; namely, that the *Air*, within which name I here comprise the *Æther*, that may be harboured in its Pores, may in some cases by its constant presence; and in others by its being alwaies at hand, & its readines to insinuate it self wherever it can get admittance, concurre to the Production of divers *Phænomena*, wherein its Cooperation has not been suspected even by Philosophers: for, not to mention what I have by Experiments purposely devised, that the Air's being present to presse upon the superficies of Liquors is so requisite in Suction, that they will not thereby be made to ascend without it; and besides that to the putrefying of some Bodies within the time (or even within ten times the time) that nature is wont to putrefy them in, they will not be brought to putrefaction, if the Air be all the while carefully secluded: besides these things, I say, I found, [that the light, which appeares in some rotten Woods and in some putrefyed Fishes did so much depend upon the presence of the Air, that if that were quite withdrawn from them, the light would disappear, and when they were restored to the Contact of the Air, they would shine forth again as formerly. But of this elsewhere.]

CHAP.

CHAP. VI.

I Know not, whether it will be fit to add, that besides what the Air (with the subtler matter that may be mingled with it) may doe as a substance; it may perform diverse things upon other accounts, as its finer parts may be, though insensibly, mov'd in *Physically* strait Lines; or as it is the subject of Swarms of Corpuscles put into peculiar, though invisible, Motions. For Instance, if I take a sheet of Paper, and rub it over with Oil, or even a fit kind of Grease; that which the Liquor apparently does, is only to pierce or soke into the Pores of the Paper, which before did by their crookedness, or upon some other Mechanicall account render the Paper Opacous. But this insinuation of the Unctuous Body into the Pores having altered them as to Figure, or to Size, or to both, and having by that alteration, given the Paper a Texture disposed to allow due Passage to the Corpuscles of Light, or to transmit their peculiar kind of Impulse (whence severall Naturalists derive Light) the Motions, as I was saying, or invisible Corpuscles in the Air, depending upon the constitution of the World, do presently act upon the Paper, and produce beyond it both a sensation of Light, and the representations of a multitude of Objects, whence the Light reflects, and which could not be seen through it before.

I need not perhaps tell you, that if a pretty large Box be so contrived, that there may be towards the one end of it a fine sheet of Paper stretch'd like the Leather of a Drum-head at a convenient distance from the remoter end; where there is to be left an hole covered with a Lenticular Glasse fitted for the purpose, you may at a little hole, left at the upper part of the Box, see upon the Paper such a lively representation; not only of the Motions, but shapes and Colours of outward Objects, as did not a little delight me, when I first caused this portable darkned Roome, if I may so call it, to be made. Which Instrument I shall not here more particularly describe, partly because I shewed it you severall years agoe, since when, diverse Ingenious men have tryed to imitate mine (which you know was to be drawn out or shortned like a Telescope, as occasion required) or Improve the Practice; and *Partly*, because, that which I pretended in mentioning of it here is, to shew, that since that almost upon every turning of the Instrument this way or that way, whether it be in the Town or open Fields, one may discover new objects, and sometimes new Landscapes upon the Paper, there must be all day long in all parts of the Air, where this *Phænomenon* can be exhibited, either certain *Effluvia* emitted every way from the Objects, or certain motions of insensible Corpuscles, which rebounding first from the externall object, and then from the Paper,

produce

produce in the eye the Images of these Objects: so that the Air is every where full of visible Species, which cannot be intelligibly explicated without the Locall motions, of some minute Corpuscles, which, whilst the Air is enlightened, are alwaies passing thorow it.

You may remember, *Pyrophilus*, that in the Clause of the second Proposition, hitherto discourſed of, I take in the establisht lawes of the Universe as a part of the present Constitution of this our World; some of those lawes contributeing much to the operation of those unheeded Causes, wee are treating of. Of these I may another time give you some Instances; but for the present it may suffice, to take notice of this one, that if you take a Barr of Iron & holding it perpendicularly apply the lowest part of it to the Northern Point of a well poised magneticall Needle, the Barr will presently drive it away: but that Magnetism, by which the Barr does it as 'tis presently acquired by the Posture which it had, so tis as suddenly changed, if you invert that Posture; as appears by this, that though you hold the Barr perpendicular, if it be held under the Needle so that the same part of the Barr which before was placed directly over the North-Point of the Needle, be held directly under the same Point, the Barr will not, as before, drive it away, but, as they commonly speake, attract it. But if this Barr have been for a long time kept in an erected Posture, as if it be taken

taken from some old VVindow, or if, having been heated and refrigerated, it have very long lain North and South, it will appear endowed with a stronger and more durable verticity, as we elsewhere more fully declare; which seemes to proceed from this, that by lying North and South it lay in the Way, which, according to the establisht Lawes of Nature; the Magneticall Effluvia of the Earth must passe along in Steames from Pole to Pole; whereby they have the opportunity by little & little to work upon the Pores of the Iron that lies in their way, and fit them to give passage to the Effluvia of Magneticall Bodies; in which fitnesse seems principally to consist the Magnetism of Iron: whereas if this Metall had all this while lain East and West, instead of North and South, it would have acquired little or noe magneticall Vertue: and the reason why an erected Posture gives a Rod or Barr of Iron a power to drive away the North Point of the Needle, has been probably conceived to be this, that the lower end being nearer the Earth does more plentifully participate of the Magnetick Steams, which fly in a closer order there, than further off, and by powerfully affecting that part of the Iron, turn it (for a time) into the Irons North Pole, which according to the Lawes magneticall ought to drive away the North Pole of the Needle, and attract the South; whereas if the Barr being inverted, that end which was uppermost becoming the lower, must for the same reason have

a contrary operation, unlesse by having long stood, its Verticity be too well setled to be suddenly destroyed or altered by the Effluvia of so Languid a Magnet as the Earth. But whether or no this explication be the right one (for I would not *contend* for its being so) It appears by the requisiteness both of a determinate Position of the Iron, and of its long continuance in that Position to make that mettal acquire a durable Verticity, that those unheeded magneticall steames, which communicate such a magnetism to the Iron, move and act according to Lawes establisht in nature: which is as much as my Designe in this discourse makes necessary to be made out.

CHAP. VII.

IT remains now, that we discourse of the last of our three grand Propositions, namely, *That a Body by a mechanicall Change of Texture may acquire or loose a fitness to be wrought upon by such unheeded Agents, and also to diversify their Operations on it upon the score of its varying Texture.*

This Proposition is of so much Affinity with the foregoing, that there are divers cases, wherein the same Experiments and other Arguments may serve for the Confirmation of Both.

But to Illustrate a little what I mean, by grosse and sensible Examples, 'tis a custome we often

obſerve at Sea, when we Sail with to ſlack a wind, to take up Water with certaine Inſtruments and throw it againſt the Sails. At the firſt Propoſall this may ſeem a very improper Way to promote the Swiftneſſe of the Ship, ſince there is the Weight of ſo much water added to that of the Veſſel it ſelfe; but yet I have ſeen the Seamen make uſe of it as one of their beſt Expedients when wee were cloſely chaſed by Pyrates, nor did I look upon it as irrationall; for whereas, when the Sails are dry, a good part of the Wind that blowes upon them eaſily gets thorow thoſe meſhes or great Pores that are left between the Threds of which a Sail conſiſts, when it comes to be wetted, the imbibed Water makes the Threds ſwell every way, and conſequently very much ſtreightens the Pores or Intervalls, that were formerly left between them; by which means the Wind cannot permeate them as freely as formerly, but by finding a greater reſiſtance in the Sail comes to beat more forcibly upon it, and conſequently drives it, and with it the Ship, more ſtrongly on, then elſe it would have done; not to mention the ſtiffneſs of the Sail acquired by the imbibed Sea water, becauſe I would not ſtay to take notice of other Particulars, to which the ſucceſſe of this practice may perhaps be in part aſcribed.

To add another Inſtance to the ſame purpoſe with the former; ſuppoſe an high Wind to blow againſt a Chamber, wherein the Windows and Doors

Doors are all shut, the effect will be only, to shake a little the Roome in generall; but if one open the Casement, though he, that do's it, doe properly & immediatly but displace some litle Peice of Iron or other thing that shuts the VVindow, yet this being done in a Place, where there is a strong Current of Air, which we call a VVind, there will presently follow a blowing up of Curtains or Hangings, and bloweing about of Dust, Straws, Feathers, or other light Bodies, that are not firmly enough fastened, nor very ponderous, and yet are to heavy too be blown about.

But to proceed to Instances that are not so grosse, I might take notice that though good common *Tartar* does usually of it selfe keep dry in the Air, nay and will not easily be dissolved in cold water; yet if it be calcin'd, though but very moderately, the Salt in the remaining Coale, the Texture being now altered, will readily enough in the moist Air (as that of a Cellar) run into that Liquor that Chymists have been pleased to call *Oyl of Tartar per deliquium*. But in regard that to make the Change the greater, part of the Tartar must be driven away by the Fire, I shall rather make use of an Example easily drawn from an Experiment I elsewhere mentioned to another Purpose; For haveing taken a Loadstone, and according to the way there delivered, heated it & coold it, though it had lost so little by the Fire, that the Eye took no notice of its being changed either as to Shape or Bulk, yet the Operation of

the Fire, by changeing the invisible Texture, did so diversly alter the disposition of it in reference to the magneticall Effluvia of the Earth, that I could presently and at pleasure change and realter the Poles of the Stone, makeing the same end point sometimes to the North and sometimes to the South. The like change of Verticity I have, as I elsewhere declare, made meer Iron capable of without the help of fire or any other Magnet then the Earth; and I have also found by Tryall, that a certaine heavy *S*tone, that is usually thought to be not so much as of a metalline nature, may by a slight and quick Preparation, that alters not the *S*hape nor Bigness, be enabled to attract and repell the Poles of a magnetick Needle.

CHAP. VIII.

TO the Instances already given in solid Bodies it will not be amiss to annex two or three in Liquid Bodies, because it may be thought strange by some, that considerable changes of Texture should, without Fire or any new Ingredients be produced in Bodies which, by reason of their Fluidity seem presently to recover their Texture if it be disordered. If Honey and VVater be each of them apart put into a convenient Vessel, they will both of them retaine their Nature, and though you mix them together in an undue Proportion,

so

so that by reason of overmuch Honey the Consistence be too thick, or that by being diluted by too great a Proportion of VVater, the solution of Honey be too thin, they may continue Honey and VVater; but if those two Liquors be duely proportioned (as if you put to one part of Honey 4 or 5 of VVater) then their new Texture so disposes them to be acted on by the Subtle permeateing Matter, or what ever other common Agent Nature employes to produce Fermentations, that the Ingredients doe no longer continue what they were, but begin to work like new Must, or Beer VVort: and I have tryed that so small and short a Locall motion (as carrying such mixtures a while in a Coach) has so excited the Liquor as to make it violently force its way out of the Vessel, or throw off the Stopple, that I have wondered at it. And I remember, that an eminent Merchant of VVines, who spent divers years in the Canaries being askt by me about some things of this Nature, assured me, that in those *Fortunate Islands* (as the Ancients Style them) he had severall times observed, that if a Pipe of the best Sort of Canary were when it was about a moneth old, rudely rould, though but the length of an Hall or moderate Gallery, so transient and slight a discomposure of the Texture would quickly make so great a Change in it, that oftentimes a good quantity of VVine would be violently thrown out at the Bung, or if the pipe were too close stopt, that great Vessel it selfe would oftentimes

tentimes have the bottom beaten out; by which means he had known severall pipes of that rich Liquor lost.

We have divers Examples of the cracking of common Glasse, when it is too soon, after it hath been removed from the Fire, exposed to the cold Air, and the subtle Bodies that are in it; which would not have crackt it, if it had been coold more slowly, so that its parts would have had leasure to settle into a Texture convenient for the Passage of those Subtle Bodies, which in that case would harmlesly have permeated it. But I have sometimes shewn the Curious a more quick and manifest Instance of the Importance of the present Texture of a Body in reference to the Catholick and invisible Causes that may work upon it. For haveing taken a plate of so ponderous and solid a Body as Copper, and heated it red hot, and then suffered it to cool a while upon some more moderately hot place in the Fire, though it did not appear at all ignited when I removed it to a Plate, or even to a sheet of Paper; yet upon its being exposed to the Atmosphere, the superficiall part would not only crack as in over hastily coold Glasse, but would, and that presently, fly off in Flakes in good number, and not without noise; so that in a short time I have had the neighbouring part of the Paper on which the Brass Plate rested, almost quite covered with little scales, as it were, of that mettall.

And to give you in favour of what I have bin hi-

therto

therto discoursing an Instance of a very subtle nature, I will not, though I justly might, take notice, that in rotten fish and rotten Wood, the change of Texture is oftentimes invisible that will suffice to make the Contact of the Air, and the Subtle *Corpuscles*, whereto it gives Harbour or Passage, confer or loose a Power of shineing, but I will rather choose to Instance in the Bolonian stone, which by calcination acquires this admired Property, that if it be but exposed to the sun Beams (to which I have found other strong lights succedaneous) it will not only in a few minutes acquire a Luminousness, but for some time after retain it in the Dark.

FINIS.

COSMICALL

SUSPITIONS

(Subjoyned as an

APPENDIX

To the Diſcourſe

OF THE

Coſmicall *QUALITIES of things.*

COSMICALL SUSPITIONS;

(Subjoyn'd as an

APPENDIX

To the Discourse

Of the Cosmicall Qualities of Things.)

IN The former Essay, *Pyrophilus*, I proposed to you some things about the Subject there treated of, that seem'd to have in them such a degree of probability, as is wont to be thought sufficient to Physicall Discourses, or at least is usually to be met with in Them. But in regard the World, whether we take it in the larger sense for the whole Universe, or in the more narrow but not lesse common acception, for the Globe we men inhabit, is a Subject so vast, that not only all demonstrable Truths that may be discovered concerning it, may be lookt upon as important, but even Conjectures and Suspitions themselves that relate to it in generall, if they be not very groundlesse or extravagant, may deserve not to be altogether passed by in silence. I will adventure to entertaine you a while with some Thoughts of this nature, especially because they will give me opportunity to alleadg in their favour

vour some Historicall observations which, whatever the Doubts or Conjectures be thought of, may appear to be more new then despicable.

It may now therefore be not unseasonable to confesse to you, that I have had some faint *Suspition*, that besides those more numerous and uniform *Sorts* of minute Particles that are by some of the new Philosophers thought to compose the Æther I lately discours'd of; there may possibly be some other kind of Corpuscles fited to have considerable operations when they find congruous Bodys to be wrought on by them. But though 'tis possible, and perhaps probable, that the Effects we are considering, may be plausibly explicated by the Æther, as 'tis already understood; yet I somewhat suspect that those Effects may not be due solely to the Causes they are ascribed to; but that there may be, as I was beginning to say, peculiar sorts of Corpuscles that have yet no distinct name, which may discover peculiar Faculties, and Ways of working, when they meet with Bodies of such a Texture as disposes them to admit, or to concur with the Efficacy of these unknown Agents.

This suspition of mine will seem the lesse improbable if you consider, that though in the Æther of the Ancients there was nothing taken notice of but a diffused and very subtle substance; yet we are at present content to allow that there is always in the Air a *Swarm* of Steams moveing in a determinate Course betwixt the North Pole and

and the South: which *S*ubstance we should not probably have dreamt of, if our inquisitive *Gilbert* had not happily found out the magnetisme of the Terrestrial Globe. And few perhaps would have imagined that when an hunted and wounded Dear has hastily passed over a little Grasse, he should leave upon it such determinate, though invisible, Effluviums, as should for many hours so impregnate the Air, as to betray the individual flying and unseen Dear; if there were no Blood Hounds, upon whose peculiarly disposed Organs of Smelling these Steams are fit to operate. And 'tis strange that there should be such Effluvia for a long time (perhaps a year or 2 together,) resideing in the Air, that though our senses discern them not, and though they have no Operation upon other men; yet if they meet with Persons of a Peculiar Temperament, who by that and by their formerly haveing had the Plague, have attained a peculiar Disposition that fits them to be wrought on by Pestilentiall *S*teams, they may so operate upon them, that some of these Persons may be able to discerne those *S*teams to be Pestilentiall. To give some countenance to which Paradox, I will here annex 2 or 3 testimonies, the first of which I find thus set down among my Adversaria. [Above 3 moneths before the late great Plague began in *London* (in the year 1665) there came to Dr. M. a Patient of his to desire his advice for her Husband, and the Dr. haveing enquired what ailed him, shee answered that his

cheife Distemper was a swelling in his Groine, and upon that occasion added that her Husband assured her of his being confident that the next Summer the Plague would be very rife in *London*; for which Prediction he gave this Reason, that in the last great Plague he fell sick of that disease; and he then had a Pestilentiall Tumour.

So in two other Plagues that since happened, though much inferior to that great one, each of them had a rising in his Body to be its forerunner, and now having a great Tumour in the forementioned place, he doubted not but it would be followed by a raging Pestilence, which accordingly ensued. Having heard much talk of something of this nature, & being this morning casually visited by the Doctor, a person of great veracity, I enquired of him how much of it was true, & I received for answer the foregoing narrative.

The *S*econd is a very remarkable story, which I remember that famous & excellent Chirurgeon *Fabricius Hildanus* records of himself, namely that having had a Pestilentiall Tumour during a Plague that happened in his youth, if for many years after he chanced to go to, or so much as to pass by, an house infected with the Plague, he was admonisht of the particular Disease that reigned there, by a sensible Pain in that part where he had had a Pestilentiall Tumuor so long before.

The third Testimony, is afforded me by that curious observer of the Changes that happened

as

as to the *Phænomena* of Diseases at the famous Seige of *Breda*, where this diligent Physitian, practising much among Patients afflicted with malignant and Pestilentiall Diseases, was at length infected himselfe; whereupon he informs his Readers, *Annotandum hic merito naturæ facultatem ad Pestis præservationem momenti esse maximi. Observavi in meipso contaminatos invisente statim inguen olere vel axillas: afficiebatur aliquando caput, noctu inde sudor, & secessus tres quatuor ve. Hoc & aliis accidit qui fideliter mihi retulerunt.*

If these stories were related by ordinary Persons of what happened to other men, the odnesse of them might well tempt a wary man to suspend his judgement: but the Judiciousnesse of the Writers, & the Profession they were of, and their relating these as things that did more then a few times happen to themselves, may well be permitted to bring Credit to their Assertions. And these Instances added to what has been already said, may I hope excuse me, if I thinke it not time mispent, to consider whether there may not be other and even unobserved Sorts of Effluvia in the Air: to excite your Curiosity and Attention about which, rather then to declare a positive Opinion, is that which is pretended to in what has been lately mentioned.

And whereas, *Pyrophilus*, I have in the former Discourse taken in the *Structure* and *establisht Lawes* of the Universe as an Helpe toward the giving an Account of the Cosmical Attributes

of things; I shall here also ingeniously confesse to you, that I much feare whether we have yet attentively enough taken notice either of the number, or the Kinds of those Lawes.

For as I am by some Notions and Observations inclined to think, that there may be a greater number even of the more generall Lawes, then have been yet distinctly enumerated; so I think that when we speake of the Establisht Lawes of nature in the popular sense of that Phrase, they may be justly and commodiously euough distinguisht: some of them being *generall Rules* that have a very great reach, and are of greater affinity to *Lawes* more properly so called, and others seeming not so much to be generall *Rules* or *Lawes*, as the *Customes* of nature in this or that particular part of the World: of which there may be a greater number, and those may have a greater Influence on many Phænomena of nature then we are wont to imagine.

And first whereas the Structure of the World is a main help in our present disquisition; I shall venture to tell you, that though I doe not only commend, but in divers cases admire, the Industry of Astronomers and Geographers, especially of some later ones, yet they have not met with such Difficulties, that they have hitherto presented us rather a mathematicall Hypothesis of the Universe, then a Physicall, haveing been carefull to shew us the Magnitudes, Situations, and motions of the great Globes, such as the fixed Stars

and

and the Planets (under which one may comprize the Earth) without being sollicitous to declare what simpler Bodies, and what compounded Ones the Terrestriall Globe we inhabit does, or may consist of. And as of late years the discovery of the 4 Planets about Jupiter, and the little moon (as some call it) that moves about Saturn, together with the *Phænomena* of Comets, have obliged the skilfull to alter divers things in the Theory of Celestiall Bodies: so I know not but that future discoveries by improved Telescopes and other Philosophicall Instruments, may reduce us to make changes in the grand Systeme of the Universe it self: and in that which we consider as the most important of the mundane Bodies to us, the Terraqueous Globe we live on.

What Communication this may have with the other Globes we call Stars, and with the Interstellar parts of Heaven, we have very little knowledge of, though I may elsewhere make it probable that there may be some Commerce or other; but without speaking more particularly of that Point, I confesse I have sometime suspected that there may be in the Terrestriall Globe it selfe, and the Ambient Atmosphere, divers whether Laws or Customs of nature that belong to this Orbe, and may be denominated from it, and seemed to have been either unknown to, or overseen by both Scholasticall and Mathematicall Writers. And first I have often suspected whether there may not be in the Mass of the Earth some

some great though slow internall Change (whether originated there, or produced by the help of other Mundane Globes) by considering that almost in all Countreys, where Observations have been made, there has been a plain and considerable alteration found it that which is commonly called the variation (for it is rather the Declination) of the sea Compasse or Magnetick Needle, which is the distance by which the Needle declines East or West from the true North Pole. And whereas formerly at or *near London the Compasse declined, as Observations solemnly made and upon record assure us, in the year 1580 above a 11 degrees, in the year 1612 above 6 degrees, in the year 1633 no lesse then about 4 Degrees, it has of late been found to have very little or no Variation. And at a place within halfe a League of London, trying with a long and curious Needle purposely made and poised, I could scarce discern any declination at all, and if the needle declined sensibly any way from the Pole, it seemed to do so a little towards the other side of Heaven thē that towards which it did decline before. And having * afterwards by the help of a meridian Line, much prized for haveing been accurately drawn by eminent Artificers, made an Observation in London it self, though I made it with two Instruments, whereof one was a choice one, differing from the former and from one another; I could not satisfy my selfe that

*at Lime House.

*A. D. 1669.

that I could discerne the Declination of the needle to exceed half a degree, if it amounted to so much. But since Observations of this kind may prove more Considerable then we yet know of, & since they ought to be made at distant places, I am contented to add here by way of Confirmation, that the *Cape of good Hope* being one of the Eminentest parts of the Terrestriall Globe in reference to magnetisms, the Acquaintance I had with one of the ancientest and most experienced navigators of this part of Europe, invited me to addresse my selfe to him purposely to enquire of him, whether he had taken the Variation of the Compasse at the *Cape of good Hope*, and whether, if at all, he had taken it more then once; he answered, that he had often done it: Whereupon askeing him what he found the Variation to be; and whether he had observed any change of It in his severall voyages, he replyed, that when he was a young Seaman he observed the Variation to be about two degrees Westward, and afterwards dureing many years that he sayled to and fro betwixt East India and Europe he found the Variation to encrease by degrees; and whereas he had learned from Ancient Writings and the Tradition of old Seamen, that before his time, they had found no Variation at all, he about 15 years agoe (which was the last time he took It) found it by accurate Instruments, to be 6 degrees & about 48 minutes. So that during the time that he practised the seas about the *Cape*

of

of Good hope the Variation still Westward had decreased near 5 degrees. Upon these Grounds, which I may elsewhere have occasion to confirm by further Observations, I cannot but think it probable that there may be Agents that we know not of, that have a Power to give the internall parts of the Terrestriall Globe it selfe a motion; of which we cannot yet certainly tell according to what Lawes 'tis regulated, or so much as whether it be constantly regulated by certain Lawes or no. And what other Changes Agents that can produce a Change in the Terrestriall Globe it selfe may make in this or that part of it who can informe us?

In the next place I consider the great uncertainty & irregularity that we have hitherto observed in the Weight of the Atmosphere by our new Staticall Barometers, and much more sensibly by mercuriall ones, without yet having discovered the Causes of such considerable Alterations in the Air, (save that in generall they proceed for the most part from Subterraneal Steames) whose influences upon other things may be more considerable then we have yet had opportunity to detect.

Monsieur de Rochefort.

'Tis very remarkable what a late and ingenious Writer that lived in some of the American Islands, relates about the Hurricans in those parts, namely that before the Europeans came thither, the Inhabitants observed that they had those Fatall Tempests once in

in 7 year and no oftner, afterwards they were troubled with them but once in *6* year, and in processe of time, the unwellcome Visits of those Winds grew so frequent, that in my Relators time they came once a year, and (as a Prodigy) they once observed 2 in one year; and afterwards 3 in another, I remēber also that meeting with an inquisitive Gentlemā that had lived in New-England, I desired to know of him whether in that part of the Countrey where he resided, there were not a great Change made in the very Temperature of the Climate? whereto he answered me that there was, for it was grown much milder then formerly; and because I doubted whether this Change might not have been, either accidentall for a year or two, or apparently to the English, whose Bodies by degrees might grow more accustomed to the Coldnesse of the Countrey, and lesse sensible of it: It was answered that this Change had been observed for many years after the English had planted a Colony there, and that the Change was manifestly perceived by the natives to, by the remisser Operation of the Cold upon running and standing Waters, which were formerly wont to be frozen at such and such times. And I shall adde for Confirmation, that haveing one day the Honour to be standing by his Majesty when he received a solemne Addresse from New-England delivered by the Governour of a Colony there, That very inquisitive Monarch, amongst other Questions askeing him

about

about the Temperature of the Air, he told his Majesty *in the presence of divers that came from America with him, that the Climate had much altered & lost much of its former coldnesse for divers years since the English setled there.*

Whether this *Decrement* of the sharpenesse of the *Air* will proceed, or how long it will continue, Time will discover. But in the mean while supposing with him the matter of Fact to be true, and that the change depends not on any manifest Cause; that which is happened already seems to me very considerable, since I have lighted on a Booke * written by * one of the Ancient Planters of New-England by way of Description of that Country; where among other things, I find this notable Passage. The one in the 7th page; In former Times (sayes He) the Rain came seldome, but very violently, continuing its drops, (which were great and many) sometimes 24 hours together, sometimes 48, which watered the Ground for a long time after; but of late the seasons are much altered, the rain coming oftner, but more moderately, with lesse Thunder and Lightnings, and suddain Gusts of Wind. And the other in the 84th Page, where speaking of the Heathen natives, He sayes they acknowledg the power of the English-mans God, as they call him, because they could never yet have power by their conjurations to damnify the English either in Body or Goods; and besides they

* *Intituled, New-Englands Prospect.*

* *Mr. W. Wood.*

they say he is a good God that sends them so many good things, so much good Corn, so many good Cattell, temperate rains, fair seasons, which they likewise are the better for since the arrivall of the English; the Times and seasons being much altered in seven or eight years, free from Lightning and Thunder, long droughts, suddain and Tempestuous dashes of Rain, and lamentable cold Winds.

So that by this it appears, that this gratefull Decrement of the coldness and rudeness of that Climate was already taken notice of so * many years agoe.

* *The Book was publisht 35 years since.*

To these Relations may pertinently be subjoyned a passage of the Learned *Magnenus* in his Ingenious little Tract *de Mannâ*; where he very solemnly delivers this notable observation, That in the Country he calls *Cenotria*, there was no Manna to be found a little above 300 years agoe. And that in *Calabria* it self, a Province so famous for Manna, that the best is denominated thence, and that furnishes a great part of Europe, with that odd Drug; 'tis but since two ages or thereabouts that *Manna* has fallen

Sanctiornm naturæ Interpretum nullus fraxinum inter arbores gummiferas, aut resiniferas recensuit.

Illud omnino quo Altomatus *sese jactare videtur, ignoravêre curiosissimi rerum indagatores* Plinius, Galenus, Theophrastus, *& qui mediam ætatem impleverunt viri doctrinâ diligentiâque celebres: quia scilicet illis temporibus multum pluebat in Calabria Manna, quod à duobus tantummodo seculis legi cœptum: Dic amabo* Altomate *cur ante trecentos annos Multum Manna fuit in* Cenotriâ, *jam certe ade-*

rant pagi ibidem urbesque vicinæ, neq; vero fefellisset curiosam in colarum solertiam nihil plane video, quod pro te adduci possit ad hujus difficultatis evitandas angustias. Magnenus de Manna *P.M.* 49.

or, as he expresses it, rained.

I know not whether it may be worth while to mention after these more weighty observations the Economicall Tradition of Huswives; which I should not think worth taking notice of in this place but that haveing purposely enquired after the truth of it, of two very sober persons (much versed in the Art of makeing *S*weetmeats) that have, especially one of them, often tryed it, they seriously affirmed to me, that they find the *S*pots made in linnen by the juyces of Fruit, particularly of Red Currans in straining Baggs, will best wash out (nay scarce otherwise) at that time of the year when those Fruits are ripe the ensueing year.

To which may be for affinities sake annexed, what is related by the ingenious French Writer of the History *Des Isles Antilles*, where he lived divers years; who speaking of the Fruit they there call *Acajou*, tells us, that the Juyce of some of the internall parts of it though reputed an excellent remedy in fainting Fits, is of such a nature, that if it chance to fall upon a peice of Linnen, it turns to a red *S*pot; which lasts till the tree come to be again in flower. Which *Phænomena* if the length of time, and the heat and Temperature of the air usuall in the Seasons of producing Blossoms, and ripening of fruits be found

Histoire Naturelle Des Iles Antilles Liv: 1 Chap: 6.

to

to have little or no interest in their Causation, may prove of some use in our present inquiry.

What ever be the true cause of the Ebbing and Flowing of the Sea, yet at Spring-Tides the motions of such vast Masses of Matter as the great Ocean, and *most* of the Seas, are *so constantly* coincident with the New and Full Moon; and the more stupendious Spring-Tides have been in *most* places, so long observ'd to happen regularly enough about the Æquinoxes, that it is worth an Enquiry, (though I cannot here afford it one) whether these conspicuous *Phænomena* may not somwhat confirm the Conjectures we are discourseing of.

And when I remember how many Questions I have askt navigators about the luminousnes of the Sea, and how in some places the Sea is wont to shine in the night as far as the Eye can reach; at other times and places only when the Waves dash against the Vessell, or the Oars strike and cleave the Water; how some Seas shine often, and others have not been observed to shine; how in some places the Sea has been taken notice of, to shine when such and such Winds blow whereas in other Seas the observation holds not: and in the same Tract of Sea within a narrow Compasse one part of the water will be luminous, whilst the other shines not at all: When I say I remember how many of these odd *Phænomena* belonging to those great Masses of Liquor I have been told of by very credible Eye-Witnesses (whose narra-

tives to me you may elsewhere meet with) I am tempted to suspect, that some Cosmicall Law or Custom of the Terrestriall Globe, or at least of the Planetary Vortex may have a considerable Agency in the Production of these Effects.

Nor am I sure that some Subterraneall Changes or some yet unobserved Commerce between the Earth and other Mundane Globes has not an interest in the origine, continuance, & Expiring of those diseases that Physitians call New, which invade whole Countreys (and sometimes greater portions of the Earth) and last very many years, if not some Ages, before they come to be extinct. Of which Sorts of diseases divers Learned men have reckoned up divers, and whereof the Venereal Pox, at least as to its origine and spreading, is but too manifest and unhappy an Instance; whereto according to some eminent Doctors, we may add the Rickets, a Disease which though scarce known in other Countreys, is here in England so fatall to Children, which first (as is affirmed discovered it selfe among us within the memories of multitudes of men yet alive: But of this perhaps more elsewhere

If I should now further descend to the Peculiar *Phænomena* of Particular Regions, I must lanch out into a Discourse I could not have the Leasure to finish. And therefore I shall only advertise you of two Suspitions more, that I hold not unfit to intimate to you, about the establisht Lawes and Customs of nature.

The

The first of them is this, that I doubt those that are thought the grand Rules whereby things corporeal are transacted, and which suppose the constancy of the present Fabrick of the World and of course things, are not altogether so uniformly complyed with, as we are wont to presume; at least as to the Lines according to which the great Mundan Bodies move, & the Boundaries of their motions. For what reason the wise Author of nature pleasd to permit that it should be sometimes, as it were overruled by the Boisterousnesse (if I may so call it) and exorbitant motions of unruly Portions of matter, I must not in this place (though I doe it in another) enquire: But when I consider the nature of Bruite matter, & the vastnesse of the Bodies that make up the World, the strange Variety of those Bodies which the Earth doth comprize, and others of them may not absurdly be presumed to containe, & when I likewise consider the fluidity of that vast Interstellar part of the world wherein these Globes swim; I cannot but suspect there may be lesse of Accurateneſse and of constant Regularity, then we have been taught to beleive, in the Structure of the universe, & a greater obnoxiousnesse to Deviations then the Schools, who were taught by their master Aristotles, to be great admirers of the Imaginary perfections of the Cælestiall Bodies, have allowed their Disciples to think. And in effect to speake only of the noblest of them, the *Sun*, and to passe by about his motions, the observation of the exactest Astrono-

mers, that natural days are not all of equall length (whatever the Vulgar of Philosophers suppose to the Contrary.) And not to take notice of the great dispute betwixt the eminentest Astronomers even of our times about the Anomalie attributed to the motion of the *Suns Apogeum*; to passe over these things, I say; the *Sun himselfe* doth not only from time to time do what divers of our latter Astronomers stile, to vomit out great quantities of opacous matter (which are called his spots) some of them bigger (perhaps) then Europe or Asia, but has had almost his whole Face so darkned with them; (as about the end of *Cæsars*, and the beginning of *Augustus*, government) that for about a year together he was as it were under an Ecclipse: To which if we add those Cælestiall Commetts (for I dispute not now about sublunary ones) their number, Vastnesse, Duration, odd motions from Orbe to Orbe, (as the Ancients would have spoken) and other *Phænomena*, (whatever the Causes of them be,) 'twill appear that even in the Celestiall part of the World, all is not so regular and unvariable as men have been made to beleive.

I had some doubts whether this might not be much confirmed by what has bin related by some Navigators that have been in the *South* Sea, about certaine Black Clouds, said to move as regularly in the Antartick Hemisphere, as the neighbouring Starrs themselves, to which some of our *English* seamen (whether first or no, I know not) have aded

certain

certaine white Clouds in the same Hemisphere move no lesse regularly. Of these Relations I say I considered, whether some use might not be made to my present purpose; but haveing made the Best inquiry I could, of those few Persons of note I could meet with, that were likely to informe me, I do uot yet see cause to alleadge these *Phænomena* by way of Arguments. But yet since I fiind that even Pilates who have been frequently in some parts of the East-Indies have not (whether because they sayled not far enough to the Southerne Pole, or upon some other score) taken notice of them. I shall subjoyne as a part of naturall History not obvious to be met with, the best account I could procure of them; which was from an observeing Captain of an East Indian Ship with which he lately adventured too unfrequented parts of the South Sea.

The substance of his answers to me about the fore-mentioned *Phænomena* was this, That he had divers times seen in the Southern Hemisphere and in that part of the milky way which is not to be seen upon our Horizon (for he says the Galaxy is either compleatly or almost a circle) two or three places that looke like Clouds and move about the Earth regularly with the white part of the Circle in 24 hours. But by what he replyed to some further questions that I asked him, I gathered that if these be the black Clouds that Navigators have spoken of, those that gave them the name of Clouds were probably much mistaken.

Since, he answered me, that these are not black but of a deep blew; which makes me suspect them to be but Perforations, if I may so speak of the milky way, by which I mean parts of the Azure-Sky that are suffered to be seen by the Discontinuations of the parts of the Galaxy. And to this account of the dark Clouds, his further Answers gave me this of the white ones; which he says, some call the magellanick Clouds, about which he Relâted.

That he had divers times seen towards the South-Pole the Clouds that some few Navigators mention to be there, and to move about the Pole in 24 hours.

That he began to discover them plainly when he was in about 18 degrees, (as I remember) of South Latitude.

That they were white, in number three, (though two of them be not very distant from each other) the greatest being far from the South Pole, the other not many degrees remoter then that Star which of the * Conspicuous ones, they reckon to be neareſt to the Pole: though it be about 11 degrees distant from it.

* *This wary Expression keeps my Relator from being contradicted by a Curious moderne Astronomer, who tells of a star not 3 degrees distant from the Southerne Pole; but then he says too, that 'tis a star of but the* 5th *magnitude.*

But from this account of his, I dare not, as I was intimating, conclude these to be such Clouds as they are taken for, because for ought I know, if

if they were lookt on through a good Telescope, they would be found Constellations of small and singly inconspicuous Stars, like those of the Galaxy the Belt of Orion &c. But to be resolved about these matters, 'tis not amisse to expect further observations; the proposed Conjectures being made but upon a supposition; (of the truth and sufficiency of the Relations.)

And thus much for the *First* of the two Suspitions that I above intimated I would propose to you the *other* is very different from it, and might seem contradictory to it, but that they belong not to the same Cases. For though I lately told you, I suspected that in some things especially relating to the Lines according to which, and the Limits within which some great masses of matter are supposed to performe their motions, there is more accurateness sansied then there really is; yet I shall now add that there are cases wherein I am not quite out of Doubt, but that we may sometimes take such things for Deviations and exorbitancies from the settled Course of nature, as if long and attentively enough observed, may be found to be but Periodicall *Phænomena* that have very long Intervalls between them. But because men have not Skill and Curiosity enough to observe them, nor Longævity enough to be able to take notice of a Competent Number of them, they readily conclude them to be but accidentall Extravagancies that spring not from any settled

and durable Causes. For the World, like a great Animall produceing some effects but at determinate seasons, as nature produces not Beards in Men till they have attained such an Age, and the *Menses* (as they call them,) use not to happen to VVomen before they come to such years, nor to last beyond such other years of their Life. As may be also observed within a far shorter compas of Time in the growth & falling of Stags hornes and Bucks. If the first man had lived but one year in the VVorld, he would perhaps have thought the Blossoming of Trees in Spring, and their bearing Fruit in Summer but an Accidental thing, and would have lookt upon the Ecclipse of the Sun as a Prodigy of Nature; observeing that though every new Moon, the Sun & she came very near together yet neither before nor after was there any such terrible *Phenomena* consequent thereupon. And we our selves may easily remember what strang conjectures we had of the strangly varying appearances of Saturn for divers years after our Telescopes first discovered them to us.

But most remarkable is that Cælestiall *Phænomenon* afforded us by the Emerging, Disappearing, and Reappearing Stars of this Age; which have been observed in the Girdle of *Andromeda*, and in or about the *Swans Brest*; (which is said to have been seen in the year 1600, and to have vanisht in 1621.) and especially that which having above 25 years agoe appeared for a while in the VVhales Neck among the fixed ones, and

and afterwards by degrees disappeared, was lookt upon by those *Astronomers* of that Time who did not outlive it, as a Cælestiall Comet. But afterwards an Ingenious English Gentleman of my acquaintance, having observed here (as well as the vigilant Curiosity of some few latter Astronomers hath taken notice of elswhere;) the Return of the like *Phænomenon* in the same part of Heaven; it begat much wonder in All (which was increased by the slow disappearing of it) and in some curious men a Resolution to have a watchful eye upon that part of the *Sky*. Since when the justly Famous *Bullialdus*, and besides some eminent forreign Virtuosi (whose names I know not) divers excellent Persons of our own Nation having taken notice of it in the wonted place, (where I had sometimes the satisfaction of seeing it;) these Observations, and especially the last Disappearance of a Star judged to have been placed among the Fixed ones, and estimated to be of the Fourth (if not the Third) magnitude, have somewhat confirmed me in the Suspition I am now treating of. For if this and the other new Stars do continue to Return periodically to the same part of Heaven where they have been already long agoe seen; as at least for as much as concerns this, its graduall increaseing after it first begins to shew it selfe, and decreaseing afterwards seem to promise; then I may with somewhat more of probability then before, suspect that there

there may be Vortices beyond the Concave surface of what we call the Firmanent; which suspition (if true) would much disfavour the Hypothesis we now have about the Systeme of the World, and will favour what I conjectured as possible about Periodicall *Phænomena*. And however; If *either* the new *Star*, without departing from its place, be only sometimes by degrees overspread and hid by Spots, like those I formerly mentioned to have obscured the *Sun*, which are afterwards by degrees also dispated, as I at first suspected: *Or* if it have a darke Hæmisphere as well as a light one, (or rather a greater part of its Globe obscure then Luminous as *Bullialdus* ingeniously conjectures) & by turning slowly about its own Center and Axis doth sometimes obvert to our eyes its Luminous part, and sometimes its dark part (as *Jupiter* is said to do its Belt-like Spots; whence it must gradually both appear and disappear; according to either of these two Hypotheses, (though not somuch as in that which preceded them,) there will be reason to question the great Uniformity imagined to be in the Cælestiall Bodies and motions; and to favour what has been proposed about Periodicall mutations in the mundan Globes; especially since these *Phænomena* argue, that even those Stars we call fixt; and have lookt upon as so invariable; are subject to mutations great enough to be taken notice of by our naked eyes at so immense a Distance. I shall

not

not here prosecute this discourse, because I would not anticipat what I foresee I shal have occasion to say about the Terrestriall Effluvia with their Causes and effects in another Discourse, but I think my selfe obliged to mind you in this place that Doubts and *Suspitions* are the only things promised by the Title of this Discourse, and therefore I shall not quarrel with you if you conjecture that though the last proposed *Suspition* may prove well grounded in some cases, yet in some others, the Exorbitancies of the matter may, if they chance to be repeated, occasion a new Custom that may have the Force of a Law in this or that part of the mundane Globes; particularly in this Terrestriall one we inhabit: As Waters by their frequent overflowings of the Banks that cannot contain them, doe sometimes make themselves new Passages by their owne Deviations, and as it were affect to run in the Channels they once made. And as it happens also in Animals that noxious Humours having once found a Vent at an Issue or an ulcer, doe constantly take their Course that way. Which brings into my mind this odd observation, that having occasion to passe some years agoe out of *England* into *Ireland*, traversing the Maritine Countey of *Waterford*, the Convoy that went with me shewed me once in my Way at a pretty distance off, a mountaine from whose

The reference here made, is to a Tract about the Effects and Causes of some unheeded Changes in the Aire.

whose higher parts there ran precipitously a River (which by my estimate was pretty broad) that within but 2 or 3 years before at furthest first broke out without any manifest Cause from a great Bogg that had been mimemorially at the top of that mountain, and to the wonder of the Inhabitants after the first Eruption of the Water had supplyed the Country with a River ever since; the Circumstances of which new *Phænomenon*, I would gladly at a nearer distance have observed, but the Convoy was not fond of a Curiosity so dangerous in an enemies Country.

Other Instances to the same purpose I cannot now conveniently stay to present you, having already made the Conjecturall part of this Essay disproportionate to the other and I hope there is already enough said in this latter part to answer my Design, which was to excite your Curiosity to seek after some Certainty touching the Things doubted of; and strive to enable your selfe by watchfull observations somewhat to ease me of the troublesome Suspitions I have confessed to you, by telling me whether they are altogether groundless or not.

FINIS.

John Boyle O'Reilly

Mr Boyles { HISTORY OF PARTICULAR QUALITIES.

THREE
TRACTS
WRITTEN
By the Honourable
ROBERT BOYLE,

Of the { *Temperature of the Subterraneall.* / *Temperature of the Submarine.* / *Bottom of the Sea.* } Regions.

OXFORD,
Printed by *W.H.* for *Ric. Davis*.
1671.

ADVERTISEMENT.

THe two following Tracts were design'd to have been accompanied by three or four Others, whereof the First, Treated about the Temperature of the Regions of the Air, as to Heat and Cold, and had been premised to the Two that now come forth, had it not been judged more proper to reserve them to accompany some other Papers concerning the Air. To the following Tract about the Submarine Regions, it is thought fit to adjoyne some Relations about the Bottom of the Sea, to which was to have been added some Observations, concerning the Saltness of the Sea; but in that Treatise, some Blanks having been left for Particulars, which the Author could not seasonably find among his Loos Papers to fill them up with, these that now appear, having no dependence on them, it was not thought fit they should stay any longer for them.

But about these severall Tracts, this Generall advertisement is to be here given, That being Historicall Pieces, consisting chiefly, (though not only,) of such Particulars, as the Author must owe to the Informations of Others, he would not stake his Reputation for the Truth of every one of them; contenting himself, to have performed what can be reasonably expected of him; which is, that he should carefully make his Inquiries from credible Persons, who for the most part, deliver their Answer upon their own knowledge, and that he should faithfully set down the accounts he procured from such Relators.

Of the

TEMPERATURE

Of the

SUBMARINE REGIONS

As to *HEAT* and *COLD*.

OF THE TEMPERATURE, Of the SUBMARINE REGIONS, *As to Heat and Cold.*

CHAP. I.

THough the *Aristotelians* who believe Water and Aire to be reciprocally transmutable, doe thereby fancy an Affinity between them, that I am not yet convinced of: yet I readily allow of so much Affinity betwixt those two fluid Bodies, as invites me (after having treated of the Temperature of the Aeriall Regions) to say something of that of the Submarine Regions: which name of *Submarine*, though I know it may seem Improper, I therefore Scruple not to make use of, because even among the Generality of Learned Men Use has Authorized the name of *Subterraneous Places*. For as these are not by this name, and indeed cannot in Reason be-supposed to be beneath the whole Bodie of the Earth, but only the *Superficiall* parts of it: so by the Appellation of *Submarine Regions* 'tis not to be supposed that the places so called are below

the Bottom of the *Sea*, but only below the ſurface of it.

But to come from words to things, I preſume it will not be expected that I that never pretended to be a Diver ſhould give of the Regions I am to treat of, an Account build on my own Obſervations; and I hope it may gratifie a Reaſonable Curioſity about a ſubject, of which Claſſick Authors are ſo very ſilent, and about which Philoſophers ſeeme not ſo much as to have attempted any Experiments (for want of Opportunities and mean to make them.) I offer the beſt Information I could ſupply my ſelfe what by purpoſely converſing with Perſons that have dived ſome without, and ſome by the help of *Engins*. To which I have added ſome reports that I judge fit to be allowed, made me by Perſons that had converſed with the Divers upon thoſe Affrican and Indian Coaſts, where the moſt famous and expert are thought to be found.

And I the rather report the Anſwers and Relationsmy Inquiries procur'd becauſe the Informations they give us concerne a ſubject conſiderable as well as vaſt, about which nevertheleſſe I among many others am not in a condition to ſatisfie at all my Curioſity by Tryalls of my own making, and becauſe alſo what I ſhall ſay will probably ſpoile the credit of the Vulgar Error that in all deepe water of which the Sea is the Cheifeſt, the lowermoſt are ſtill the warmeſt parts, unleſſe in caſe that in ſome very hot Cli-

mates

mates or seasons, the superficiall ones happen to be a little warm'd by the Extraordinary or Violent heat of the *Sun*.

CHAP. II

THough the Air and the Earth have been discriminated as to Temperature into three Regions; yet the Informations I have hitherto met with, invite me not to assign to the *Sea* any more then two. The former of which may be supposed to reach from the superficies of it, as far downwards as the manifest operation of the variously reflected and refracted Beames of the *Sun*, or other Causes of warmth penetrates: from which to the Bottom of the *Sea*, the other Region may be supposed to extend.

According to this Division the Limits of this upper Region will not be alwaies constant; for in the Torrid Zone and other hotter Climates, it will, *Cæteris paribus*, be greater then in the Frigid Zone or in the Temperate Zones: and so it will be in *Summer* then in *Winter*: and in hot weather then in Cold; supposing in these Cases the Heat to come from the Sun and Air; and not, as sometimes it may do, from the Subterraneall Exhalations.

The same causes are likewise proper as 'tis manifest to alter the Temperature as well as the Bounds of this Region, But this Temperature

may also be changed in some few places by at least two other Causes; The one is the differing constitution of the Soil that composes the Shore, which may affect the neighbouring water if it doe extraordinarily abound with Nitre, loosely contexed marchasites, or other substances capable considerably to encrease or lessen the Coldnesse of the water. Another though unfrequent Cause, may be the figure and situation of the lesse deep parts of the Shore, which may in some sort reverberate the Heat that proceeds from the *Sun*; and upon such an account may either add to the warmth, or allay the Coldnesse that would else be found in the neighbouring water. For whatever the *Schools* are wont to teach about the Intereſt of the Attrition of Air in the heat produced by the *Sun Beams*, I have elsewhere shewn by Experiments, that those Beams may considerably operate upon Bodies placed quite under water.

Besides these two Cases that may occasion Exceptions to the generall Observation; I intimated by the words, *at least*, that there might be others. Because, to mention now but one Example, though it seem probable from what I have elsewhere delivered concerning the *Subterraneall* Fires and Heats, that may in some places be met with, even beneath the bottom of the *Sea*, that the *Phænomenon* I am going to recite may be reduc'd to the causes newly intimated; *yet* I am not absolutly certain but that in this case, whereto some others may perhaps be found resembling, some other

cause

cauſe, then thoſe hitherto mentioned, may produce or concurre to the effect. The Relation here meant is afforded us by the following Paſſage, taken out of the Voyage of *Monſieur de Monts* into *New-France*, (whereof he went to be Governor) where the Relator thus recites his obſervation. *About the eighteenth day of June we found the Sea-water* during three dayes ſpace very warm, and by the ſame warmth, our wine alſo was warme in the bottom of our ſhip; yet the Air was no hotter then before. And the 21 of the ſaid moneth, quite contrary, we were 2 or 3 days ſo much compaſſed with miſts and cold, that we thought our ſelves to be in the moneth of *January*, and the water of the *Sea* was extreame cold: which continued with us untill we came upon the Bank by reaſon of the ſaid miſts, which outwardly did procure this cold unto us. This effect he attributes to a kind of Antiperiſtaſis in the following part of his narrative; which I ſhal not now either tranſcribe or examine.

CHAP. 3

And thus much being breifely noted touching the upper Region of the *Sea*, and the requiſite Cautions (that may perhaps extend further then it) being premiſed; it remains that I take notice of the Temperature of the Lower Region, which, in one word, is Cold (unleſſe in ſome few places to be preſently mentioned.) For water being

ing in it's naturall or most ordinary state, a liquor whose parts are more slowly agitated then those of mens Organs of Feeling, must be upon that account Cold as to sense: and consequently it need not be strange that those parts of the Sea, which are too remote to be sensibly agitated by the Sun-Beams, or wrought upon by the warmth which the Air and upper parts of the Earth may from other Causes receive, should be felt Cold by those that descend into it; unlesse in those few places where the Coldnesse may be either expell'd or allay'd by hot Springs or Subterrestriall Exhalations, flowing or ascending from the subjacent Earth, or the lower parts of the shore into the incumbent or adjacent parts of the water.

To justifie my ascribing of this Coldnesse to the second, or lower Region of the Sea, I shall now subjoin some Relations I procur'd from persons that had occasion to goe down into it, or otherwaies take notice of its Temperature in very differing Regions of the World, and at very unequall depths.

And first as to the Temperature of the lower Region in the *Northerne Sea*, I had the opportunity to converse often, and sometimes to oblige a man bold and curious enough, who for some years got the best part of his subsistence by descending to the bottom of the Sea in an Engin, whose structure I elsewhere describe, to seek for, and recover Goods lost in Shipwrackt Vessels. This person I diligently examined about divers

Submarine Phænomena, about which his answers may be elsewhere met with. And as to the Temperature of the lower parts of the Sea (the knowledge of which is that alone that concerns us in this place) he severall times complained to me of the Coldnesse of the deep water, which kept him from being able to stay in it so long as he might have been put into a condition of doing by the goodnesse of his Engin; for I remember that he related to me that he staid once betwixt an hour or two, at a depth that was no greater then 14 foot and a half upon the coast of Sweden, in a place that was near the shore; and I afterwards learnd that he staid much longer in a deeper place; (use having probably made the Cold more supportable to him) He told me then, that about two years before he was engaged by a good reward to goe down with his Engin to the bottom of the Sea to fetch up some Goods of value out of a Ship that had been cast away there within about a miles distance from a very little Island, and if I mistake not about *6* miles fromt he Shore. He farther answered me that though he felt it not at all Cold on the Surface of the Water (his attempt being made in *June*) yet about the depth of the Ship, it was so very Cold, that he felt it not so Cold in *England* Winter and Frosty VVeather. And he told me that an excessive Cold was there felt not only by him but by very sturdy men, who invited by his example, would needs also goe down themselves to participate and promote the hoped

hoped for Discovery. He told me also, that the upper water did but cool and refresh him; but the deeper he went the Colder he felt it, which is the more considerable, because he had some times occasion to stay at 10 fathoms or even 80 foot under water. And I since found that he informed divers Virtuosi, that purposely consulted him, that he found the Coldnesse of the Water encrease with its depth: and gave that for the reason why he could not stay so many hours as otherwise he might, at the bottom of the Sea. Adding that before his Engin was well fitted, he was once so covered over with it, that he was forced to touch the ground with his hands and feet, and the neighbouring parts, to which he found a Coldnesse communicated by the *Fundus* he lean'd upon; though the closeneſse of his disordered Engin made the other, and (whilst he was in that posture) upper parts of his Body, of a very differing Temper.

An inquisitive person of my acquaintance that made a long stay in the *Northerne America* (at about two or three and forty degrees of Latitude) and diverted himselfe often with swimming under water, answered me, that though he scarce remembred himselfe to have dived above two fathoms beneath the surface of the *Sea*; yet even at that small depth, he observed the water to increase in coldnesse, the lower he descended into it. Which argues, that though the Sun-Beams do often penetrate plentifully enough to carry light

to

to a great depth under water; yet they doe not alwaies carry with them a ſenſible heat: and that at leaſt in ſome places, the upper Region of the *Sea* reaches but a little way.

The coldneſſe of the Climate in theſe weſtern parts of Europe, and the want of conſiderable inducements to invite men to dive often to any great depth into our Seas, has kept me from being able to procure many obſervations about the temperature of their lower Region, but upon the hotter Coaſts of Africk, and the Eaſt-Indies, the frequent Invitations men have to dive for Corall, pearles, and other *Submarine Productions*, has made it poſſible for me to get more numerous obſervations: ſome of which I ſhall now annex.

CHAP. 4.

MEeting with a Perſon of Quality who had been preſent at the fiſhing of Corall upon the ſhoar of Africa, and Who was himſelfe practiſed in diving, I inquired of him whether he found the *Sea* upon the African Coaſt to be much colder at a good depth, then nearer the ſurface; whereto he anſwered me, that though he had ſeldome dived above three or four fathoms deep, yet at that depth he found it ſo much colder then nearer the Top of the water, that he could not well endure the coldneſſe of it.

And when I farther asked him whether when he was

was let down to the bottom of the *Sea* in a great diving Bell (as he told me he had been) he felt it very cold, though the water could not come immediately to touch him, he replyed that when the bell came first to the ground, he found the Air in it very cold, though after he had ſtaid a while there, his breath and the ſteams of his Body made him very hot.

That alſo at a greater depth in thoſe hotter Climates the *Sea-water* is ſenſibly Cold may be thus made probable, Inquiring of a famous *Sea*-Commander who had been upon the Affrican Coaſt, to what depth he was wont to ſinck his Bottles to preſerve his Wine any thing coole in that exceſſive hot Climate, he Anſwered me that in the day time he kept it in a tolerable temper ſo as to be drinkable, by keeping it in the Bottom of the ſhip, and in ſand, but in the morning he had it coole enough by ſincking his Bottles over night into the *Sea*, and letting them hang all night at 20 or 30 fathom deepe under water.

Inquiring alſo of an intelligent Gentleman that was imploy'd to the river of Gambra, & ſayl'd up 700 miles in it, in a ſmall frigot, whether he had obſerved that in the *Sea*, even of thoſe hot climats, wine may be preſerved coole, he told me that it might, and that by the means I hinted to him, which was to let down when the ſhip came to an Anchor in the Evening ſeverall Bottles full of wine (they uſed that of *Madera*) exactly ſtoped to ten, 12, or 14 fathoms deep, whence being the next morn-

morning drawn up, they found the wine coole and fresh (as if the vessels had been in these parts drawne up out of a well) provided it were presently drink, for if that Circumstance were omitted, the heat of the Aire on the upper part of the water would quickly warme the Liquor.

I remember too, that having met with a man of Letters that sail'd to the East-Indies in a *Portugal-Caraet*, I learnt by enquiry of him, that 'twas the practice in that great Vessell for the Captain and other Persons of note, whilst they passe through the Torrid Zone, to keep their Drink, whether Wine or Water, cool, by letting it down in bottles to the depth of 80, 90, anc sometimes an hundred Fathom or better, and letting it stay there a competent time; after which he told me he found it to be exceeding cool and refreshing.

Lastly, to satisfie my selfe as far as I could, to how great a depth the Coldnesse of the Sea reached; meeting an observing Traveller whose affairs or Curiosity had carried him to divers parts both of the East and VVest-Indies, I enquired of him whether he had taken notice of any extraordinary deep soundings in the vaster seas, To which being answered, that some years agoe sailing to the East Indies in a very great ship, over a place on the other side the Line that was suspected to be very deep, they had the Curiosity to let down 400 Fathom of Line, and found they needed no lesse. Whereupon I enquired of him, whether he had

taken

taken notice of the Temperature of the sounding Lead assoon as 'twas drawn up: To which he told me, that he, and some others did; and that the Lead which was of the weight of about 30, or 35 l, had received so intense a degree of coldness as was very remarkable; insomuch that he thought that if it had been a masse of Ice, it could not have more vehemently refrigerated his hands: and when I asked in what Climate this observation was made, he told me 'twas in the Antarctick Hemisphere, but at a great distance from the Line. As indeed I concluded by some Circumstances he mentioned to me, that 'twas about the 35 th degree of Southern Latitude.

CHAP. 5.

These are the cheife Relations I have hitherto been able to procure about the Temperature of the *Sea*; which if they be so confirmed by others, as that we may conclude they will generally hold; it wil not be irrational to conceive that in reference to Temperature, those two Fluids, *Air* and *Water*, may have this in common, that where their *Surfaces* are contiguous, and in the neighbouring parts, they happen to be sometimes cold, and sometimes hot, as the particles they consist of, chance to be more or lesse agitated by the variously reflected *Sun-Beams*, or more or lesse affected by other causes of Heat.

But

But that part of the Air which they call the second, & is superior to the first, as also the lower Region of the Sea, being more remote from the operation of those causes, doe retain their naturall or more undisturbed Temperature, which, as to us men, is a considerable degree of coldness, the Agitation of their small parts being usually in those Regions much inferior to that of the *Spirits*, *Blood*, & other parts of our Organs of Feeling. *So* that the Regions of the *water* and *Air* seem to answer one another; but in an inverted order of situation, and the *Analogie* might perhaps be carryed further, if I had time and opportunity to doe it in this place. And here I shall not dissemble that I was somewhat perplexed by meeting with a traveller that had visited the *East-Indian Coast*, near the famous *Cape* of *Comory*: for asking him some questions touching the neighbouring *Sea*, *I gathered* from his discourse, that he concluded from that of some Divers, that the *Sea* near *Ceylom* was warmer at the bottom then at the top. And when I thereupon asked him *whether* this happened not in their *Winter*, he replyed that it was indeed Winter, though not with us, yet with them; it occurr'd indeed to my thoughts on this occasion, that perhaps in a part of the Torrid Zone so near the Line as about 80 degrees, if the *Sea* were not of a considerable depth, the heat of the two not far distant shores of *Coromandell* and *Ceylom* might have no small influence upon the Temperature of the water. I considered also (which did

did not a little weigh with me) that in divers parts of the East-Indies, and even in a Region bordering upon *Coromandell*, where an ingenious Acquaintance of mine lived some years, it has been observed, that *Winter* and *Summer* are not so much discriminated by Cold weather & Hot, as by very Rainy weather and very dry. Nay in some places the sultry heat of the Climate is more complained of, in what they call their *Winter* then their *Summer*. So that there will be no necessity to recur to an *Antiperistasis* occasioned by the coldnes of the *Winter*. I thought too, that it may perhaps be without absurdity suspected, that as the bottom of the *Sea* in this place had a peculiar Constitution that fitted it more then others for the copious production of pearls: so there might be some peculiarity in the nature of the subjacent Soil, or there may be some Subterraneall Fire or heat beneath it, which may occasion an unusuall warmth in that part of the Sea, by w^ch^ cherishing warmth, perhaps such abundance of shell Fishes teeming with pearls, may be invited to settle there rather then in any of the neighbouring places. But with all these conjectures, I should not have been so well satisfied, as with the answer I afterwards obtained by a Gentleman whose Curiosity had carried him to be an assiduous *Spectator* of the famous pearl-fishing near the *Island* of Manar; between that and the Coast of *Coromandell*, which reaches near, if not fully to the *Cape* of *Comoris*. For this Person having had much Conversation with the

Divers

Divers for Pearls, not only learn'd from them, that they found the water very ſenſibly Cold at the bottom which in ſome places he eſtimated to be 80 or 100 fathom deep; but obſerv'd divers of them at their return to the Boats, to be ready to ſhake with Cold, and haſten to the fires that were kept ready for them in little Cabines upon the ſhore: Which Relation being accompanied with divers Circumſtances of credibility and arguing the perſon that made it to have been acquainted with the report above mentioned, and had met with ſome that had dived in the place whereto it had relation, made me conclude that as to that report hither ſomething extraordinary had happened in that place, or that there was ſome miſtake of him to whom 'twas made, or that divers did not deſcend to a ſufficiently conſiderable Depth

If I had been furniſhed with opportunity, I would have engaged ſome ingenious Navigators to examine the Temperature of the Submarine-Regions, both of differing ſeaſons of the year (eſpecially the hotteſt part of *Summer* and Coldneſs of *Winter*, & with Hermetically ſeal'd Weatherglaſſes in order to the Diſcovery of ſuch Particulars as theſe; *Whether* there be in ſome Seas any ſuch varying Differences of Temperature, as may invite us at leaſt in ſome places, to make more then two Submarine Regions. Whether the Submarine Coldneſſe do at the bottom of the Sea, or elſewhere either Equall or

ſurpaſſe that degree which we here find ſufficient to freeze common water. *Whether* the parts of the Sea-water are ſtill the Colder, as they are the deeper, And *Whether* or no this increaſe of Coldneſſe be regular enough to be reducible to any ſettled proportion. But for the reſolving of theſe and the like Queſtions, I did not cauſeleſſely intimate that a ſealed Weather-glaſs was to be employed; for I take a common one to be altogether unfit for ſuch purpoſes, not only becauſe the Sea-water would mingle with ſuch Liquors as are wont to be employed in it, for that Inconveniency I could eaſily remedy, by ſubſtituting, as I have ſeverall times don in other caſes, *Mercury* inſtead of ordinary Liquors: but cheifely becauſe the incumbent Sea-water would gravitate upon the reſtagnant Liquor of the Weatherglaſs, and thereby render its Informations falſe or uncertain. According to what I have had occaſion to obſerve in another Tract.

Whereto, that there may not in this place be any need to recur, I ſhall add a ſlight experiment that I made for the ſatisfaction of ſome Ingenious men not well acquainted with *Hydroſtaticks*, or not rightly principled *in them*. And this Tryall I ſhall the rather mention, becauſe many will not allow Water to preſs upon *Mercury* immersd therein, *this* being a far more ponderous Liquor then that; and others will expect, that the included Air, having no place to eſcape out at, ſhould reſiſt the aſcenſion of the ſubjacent Mercury, more than

than indeed it will. VVe made then a ſmall VVeather-glaſſe differing from common ones, (beſides the bigneſſe,) in that it was furniſhed with *Mercury* inſtead of *Water*; and in that we employed to contain the ſtagnant Mercury, a Glaſs Vial with a narrow neck, wherein (by a piece of Cork or two) the *Stem* of the Glaſs ball was well faſtened that this globula put of the Inſtrument might not be lifted up when it was under water. Then having by applying cold water to the outſide of the Ball endeavoured to reduce the Air to the ſame Temper with the VVater, or at leaſt to an approaching degree of Coldneſſe; and having taken notice of the *Station* of the Mercury in the ſhanck or ſtem above mentioned; we did, (by ſtrings tyed about the neck of the ſmall Vial) let the Inſtrument gently down into a large tall glas Body filled with fair water that the Liquor and Veſſell being both tranſparent, we might eaſily perceive the motions of the Mercury in the ſlender pipe. By which means it appeared, that as the *Thermometer* deſcended deeper and deeper into the VVater, the Mercury was preſſed up higher and higher in the *Stem*. And that it may not be ſuſpected, that this aſcenſion proceeded only, or chiefely, from the refrigeration of the Air by the VVater, I ſhall add to what I have juſt now noted, that though the Coldneſſe of the VVater may well be ſuppoſed uniform as at leaſt to ſenſe; yet the whole inſtrument being leaſurely removed ſometimes to the upper ſur-

face of the Water, sometimes to the lower, the rising and falling of the Quicksilver in the slender pipe was suitable to the depth of its surface, or its distance beneath that of the VVater. (The like Experiment we might have tryed with a *Thermoscope* furnished with Water and let into Oyl; or with deliquated *S*alt of Tartar and pure *S*pirit of Wine instead of Mercury and VVater: if we had been furnished with sufficient quantities of those Liquors, and had judged it to be requisite.) But this Circumstance, I thought fit to admonish the spectators of, that 'tis not to be expected, that the Mercury should rise as much in proportion when it is (for example) a foot under water, as when it is but two or three Inches; because according as the Instrument is let down deeper and the Air crowded into a less room, the *S*pring of that compressed Air becomes the stronger and makes the more resistance. Which Advertisement agreed well with the Experiment, whose other *Phænomena* I passe over as not pertinent to this place, where I would only justifie what I said of the unfitnesse of VVeather-glasses made (though with other Liquors) after the Common wayes for making the Submarine Tryalls I proposed.

But till such Artificiall Observations can be obtained we may from what has been above delivered, probably gather that though the lowermost of the Submarine Regions be very sensibly Cold, yet VVater, at least that of the Sea, does not by

these

these *Phænomena* appear to be the *Summum Frigidum*. Though I have been severall times able to produce Ice in Salt-water, yet *I* find not by any Observation, that there has been Ice met with and generated at the bottom of the *Sea*, under which the Earth has been found unfrozen by our Divers; and appears to be soft at depths exceedingly surpassing the greatest they have reacht; as is evident by the Mudd, Gravell, &c. fetch'd from the bottom of the *Sea* by sounding plummets, let down to 80 or 100 fathom, or even a greater depth, whereof examples may be met with in the Journalls of Navigators; nay, my curiosity procured me this account, from the sober Commander of a ship, that came this year from the remoter parts of the great Ocean, that at about 35 degrees of *S*outhern Latitude, the tallow with which his sounding Lead was anointed brought him up gray *S*and from the immense depth of no less then two hundred & twenty Fathom. But to this Observation 'tis just to annex this Caution, that we cannot safely conclude from mens finding no Ice at the bottom of the *Sea*, that the Cold there cannot be very intense; for as I have found by more then one Relation (* elsewhere recited) that, whatever the Schools surmise, the *Sea* is at least as Salt at the bottom, as at the top: so I have more then once tryed, that Salt water will without freezing admit a much greater degree of Cold, then is necessary to turn fresh Water into Ice

* *Notes about the Saltnesse of the Sea*

FINIS.

RELATIONS

About the

BOTTOM OF THE SEA

RELATIONS
about the
Bottom of the Sea.

The First SECTION.

I Do not pretend to have visited the Bottom of the Sea, but since none of the Naturalists whose writings I have yet met with, have been there any more then I, and 'tis great rarity in these cold parts of *Europe* to meet with any men at all that have had at once the Boldnesse, the occasion, the Opportunity and the Skill to penetrate into those conceal'd and dangerous Recesses of Nature, much less to make any stay there, I presume it will not be unpleasant, if about a subject, of which, though none of those very few Naturalists that write any thing at all, write otherwise then by hear-say, I recite in this place, what I have learn'd by Enquiry from those Persons that among the many Navigators and Travellors I have had opportunity to converse with, were the likeliest to give me good Information about these Matters.

It would be needless here to take notice, that the Sea is usually Cold and Salt at the bottom, nor to repeat those other Things that I have already

ready delivered in other Diſcourſes. I ſhall therefore begin what I have to ſay in this, by relating that one of the chief things that I was ſolicitous to enquire after about the Bottom of the *Sea*, was, the inequality I ſuppoſed to be in the *Soil*. For though the ſurface of the *Sea* when 'tis not agitated by the winds, appears very plain and levell, and though it be indeed, at leaſt in this or that particular *Sea*, *Sphæricall* and (Phyſically ſpeaking) concentricall to the earth; yet I could not think it probable, for Reaſons not neceſſary to be here diſcourſed of, that the Bottom, the *Superficies* of the Ground, or of the Veſſell that contained it, ſhould be either flat or levell, or regularly concave.

To ſatisfy my ſelfe about this matter, I enquired of a Perſon that had viſited the famous Pearl fiſhing at the little Iſland of *Manar* (near the rich Iſle of *Ceylon*) in the Eaſt Indies, and had by his ſtay there much opportunity to ſee Divers at their Work and converſe with them. By the Anſwers of this man who was a *Scholler*, I learnt, that the Divers had aſſured him, That they found the Floor of the *Sea*, if I may ſo call it, in divers places exceedingly unequall, in ſome places being flat, in others aſperated with crabby Rocks a conſiderable height, and elſewhere ſinking into precipitous depths in which they found it very cold.

Beſides the recited Teſtimonies of the Divers, I enquired of ſeverall Pilates and other Navigators

tors, that had made long Voyages, what graduall or abrupt inequality they had obſerv'd at their Soundings in very neighbouring places; it being eaſy to be gathered from thence, whether the Sea were there uniformly deep, or did at leaſt with ſome regularity alter its depth by degrees, or whether as I ſuſpected, there were not at the bottom of the Sea, hilly places, and ſteep Præcipices, and perhaps deep Vallies or Wells, as we obſerve in the diſcovered part of the Terreſtriall Globe.

By theſe inquiries I obtained ſeverall Obſervations, whereof the moſt materiall are thoſe that follow.

Firſt, An ancient *Sea*-Commander, that had many years frequented Africa and the Indies, told me as others had don before, that when they ſail'd in the Ocean very far from ſight of Land, they did not often put themſelves to the trouble of *S*ounding, but that as far as they had *S*ounded, he had uſually found the depth of the *S*ea, to increaſe or decreaſe gradually, without very great irregularities, excepting ſome places, inſtancing particularly in the Excavation that makes the Bottom of the *S*ea, within ſight of the *Cape of good Hope*, where though for the moſt part, he found the water to deepen more and more as he ſailed farther from the ſhore; yet in one place, he and others had met with a Bank (as he conceived it to be) at a conſiderable diſtance from the ſurface of the Water. *S*o that though when they were

were as they imagined near the edge of that bank, they found but a moderate number of fathoms, yet when sailing a very little way farther, they had gone beyond it, they found the *Sea* of an immense depth. In short, I gathered from his Answers, that in the greater *Seas*, he had found for the most part, the ground at the bottom, to fall away by degrees; but nearer the shores, that is, within a moderate number of Leagues, he observed in divers places that the *Submarine* Ground was very unequall, and had as it were, Hills and Præcipices.

A man of Letters, that had sailed both to the East and West Indies, and in divers other Regions besides, and had made some of his Voyages in ships of such great burden, as obliged the Marriners to be very frequent and carefull in sounding, informed me, that some times at considerable distances from shore, he had observed the *Sea* to be 20, 30, or perhaps 40 fathom deeper when they cast the sounding Lead from one side of the ship, then it had been just before, when they had sounded from the other, and from other Things that he told me, I found my self much confirmed in the above proposed Opinion.

Hearing of a *Sea*-Captain of extraordinary skill in Maritime Affairs, that was come home this year from East-India, his reputation made me endeavour to have a little conference with him, about the subject of this discourse; but his occasions hastening him to another place before

I could send to him, *I* procur'd from the chief Persons that employ'd him, a sight of some Notes, touching his last Voyage, which he had left with them; hoping to find there something at least, about the *S*oundings of so accurate a *S*eaman, and accordingly I met with a Passage, very pertinent to my purpose, and worthy to be here transcribed.

Febr. 12. After our Observation, (he means a former one very agreeable to this) seeing the ground under us, we heav'd the Lead, and had but 19 fathom rocky ground, then hal'd by N.N. E^t. the Wind at N.W. and found our water to shoale from 19 to 10 and 8 Fathom hard Corall Ground, then suddainly deepned again from 8 to 20 and 22 fathom *S*andy Ground, and then suddainly saw Rocks under us, where we had but 7 fathom, and the next cast 14 fathom again. And so having run N. N. E^t. from 6 in the morning till 12 at noon about 19 mile, we deepen'd our VVater, from 16 to 25, and the next cast, no ground with 35 fathom of Line.

Lastly, having opportunely met with an Ancient Navigator, who passes for the most experienced Pilate in our Nation for an East Indian voyage; *I* asked him about his own Observations concerning these unequall *S*oundings, *I* was answer'd, that he had not only met with them elsewhere, but that not far from the mouth of our Channell, he had sometimes found the bottom of the *S*ea so abrupt, that in sailing twice the Length

Length of the ſhip, he had found the VVater deepen from 30 fathom to a hundred, if not alſo much more.

Since I received theſe Relations, having the honour to diſcourſe with a Noble Perſon, who has divers times deſervedly had the command of Engliſh Fleets, and is no leſs curious then intelligent in Maritine affairs, I took the opportunity to inquire of his Lordſhip, whether he had not obſerv'd the bottom of the Sea to be very unequal in neighbouring places? To which he reply'd, that he had found it exceedingly ſo. And to ſatisfy me that he ſpoke not upon meer cõjecture, he told me that ſailing once with his Fleet even in our Channell, he perceived the VVater to make a rippling noiſe (as the Sea-men call it) as the Thames does under London Bridge. So that he was afraid they were falling upon ſome ſhoale, the VVater being 12 or 14 fathom deep, and going on a little farther, he caſt out the Plummet again, and found it about 30 fathom. He added that he made divers ſuch Obſervations, but took notice of ſuch rippling VVaters only when the Tide was ebbing: and yet in a deep Sea meeting with the like appearance in the upper part of the water, and thinking it improbable that there ſhould be any ſhoale there, he ordered the depth to be ſounded, and found it to exceed 30 fathoms; and after he had paſſed on a very little farther, he found the Sea ſo deep, that he could not fathom it with his ordinary Line.

THE

The Second SECTION.

ANother thing obſerv'd at the Bottom of the Sea, is the great preſſure of the water there againſt other Bodies. For what ever men may Philoſophize in their ſtudies, and may conclude from the Principles that are generally received about the *Non-gravitation* of Water in its proper place, yet experience ſeems very little to favour that Generall Doctrine.

For firſt, I remember that having caus'd a pretty large Cylinder of Glaſs, that was open only at one end, to be ſo depreſs'd into a large Glaſs-veſſell full of water with a conveniently applyed weight of Lead, that none of the air could get out, I could eaſily diſcern through the Liquor and Veſſells, which were all tranſparent, that as the inverted Cylinder deſcended deeper and deeper, the externall Water compreſs'd the impriſon'd air, and aſcended higher and higher in the Cavity of the Cylinder, againſt whoſe ſide we had before hand plac'd a row of Marks, whereby to take notice of the graduall aſcent and deſcent of the Internall Water.

Secondly having inquired of two ſeverall obſerving Perſons, whereof one had with a Diving Engin viſited the bottom of the Sea in a Cold Northern Region; and the other had done the like in an Engin much of the ſame ſort, upon the coaſt of Africk, I found their Relations to agree

in

in this, that the deeper they descended into the Sea, the more the air they carried down with them was compassed, and the higher the Water ascended above the Lip, or Brim of the Engin into the Cavity of it.

But I shall now add a more considerable experiment or two, to the same purpose. For discoursing one day with an Engineer of my Acquaintance, that had been often at Sea, and loved to try Conclusions, of a way I had thought of, to make some estimate of the pressure of the water at a considerable depth beneath the surface, and shew that the pressure is great there, he told me he could save me the labour of some Tryalls, by those he had made already, and assured me that having divers times opportunity to sail near the Straights Mouth, over a place where the Sea was observed to be of a notable depth, he had found, that if he had let down with a weight into the Sea, not a strong round Glass-bottle, but a Violl, such as the Seamen use to carry their Brandy and strong waters in, such a Vessell which might contain a Pint or a Quart of water, would when it came to be sunk 40 fathom under water, if not sooner, be so oppress'd, by the Pressure of the incumbent, and laterall Water, as to be thereby broken to pieces.

He also averred to me, that having exactly closed an *Æolipille* of Metall, and with a competent weight, sunk it to a great depth in the Sea, as to forty, fifty, or sixty fathom deep, when he pulled

pull'd it up again, he found to his wonder, that the great preſſure of the water, had in divers places cruſht it inwards. And though I had ſome ſuſpition, that the coldneſs of the Sea at ſuch a depth, might by weakning the ſpring of the included Air, ſomething contribute to the effect, yet I did not admire the event, having divers years before had a thin *Æolipile* of Copper cruſht inwards by the preſſure of a much lighter Fluid then Sea-water.

The Third SECTION.

ANother thing obſerved in the Bottom of the Sea is, the Tranquillity of the VVater there, if it be conſiderably diſtant from the ſurface. For though the VVinds have power to produce vaſt waves in that upper part of the *Sea* that is expos'd to their violence, yet the vehement agitation diminiſhes by degrees, as the Parts of the *Sea*, by being deeper and deeper, lye more and more remote from the ſuperficies of the water. So that the Calm being leſs and leſs diſturb'd towards the Bottom of the water, if that lye conſiderably deep, the water is there either calm, or ſcarce ſenſibly diſturb'd.

But that is for the moſt part to be underſtood, of places at ſome diſtance from the ſhore; for ofttimes in thoſe that are too near it, the progreſs of the waters being rudely checkt, and other circumſtances concurring, the Commotion of the water is ſo great, that it reaches to the very bottom, as may appear by the heaps of *Sand*, the Amber, and in ſome places, the ſtones that are wont to be thrown up by the Sea, in, and after ſtormes.

The above mentioned Calmneſs of the Sea at the Bottom (will I doubt not) appear ſtrange to many, who admiring the force of ſtormy Winds, and the vaſtneſs of the VVaves they raiſe, do not at the ſame time, conſider the almoſt incompara-

bly

bly greater Quantity, and weight of VVater that must be mov'd, to make any great commotion at the bottom of the Sea, upon which so great a Mass of *S*alt-water, which is heavier then fresh, is constantly incumbent. VVherefore for the Proof of the propos'd Paradox, I will here set down a memorable Relation, which my inquiries got me from the Diver elsewhere mentioned, who by the help of an Engin could stay some hours under VVater.

This Person then being ask'd, whether he observed any operation of the VVinds at the bottom of the *S*ea, where it was of any considerable depth? Answered me to this purpose, That the VVind being stiffe, so that the waves were manifestly six or seven foot high above the surface of the VVater, he found no signe of it at 15 fathom deep; but if the Blasts continued long, then it mov'd the Mudd at the Bottom, and made the water thick and dark. And I remember he told me, which was the Circumstance I chiefly design'd, that staying once at the bottom of the *S*ea very long, where it was considerably deep, he was amaz'd at his return to the upper parts of the water, to find a *S*torm there which he dreamt not of, and which was raised in his absence, having taken no notice of it below, and having left the Sea calm enough when he descended into it.

For farther Confirmation, I shall add, that having inquired of a great Traveller, who had assisted at a rich Pearl-fishing in East Indies, whe-

ther he had not learnt by his Converſation with the Divers, that ſtorms reach not to the bottom of the *Sea*, if it be of any conſiderable depth, he anſwer'd, that he had ſeen the Divers take the Water, when the Sea was ſo very rough, that ſcarce any Veſſells, would hazard themſelves out of Ports, that thoſe returning Divers told him, that at the Bottom, they had found no diſturbance of the Water at all. Which is the more conſiderable, becauſe of the ſcituation of that place where they dive for Pearls; for this is near the ſhore of *Manar*, and that it ſelf is ſealed between the great Iland of *Ceylon*, and the vaſt Cape of *Comori*: and though it may be much nearer the former, is not yet far diſtant from the latter. Which ſcituation and the Neighbourhood of the vaſt Indian Ocean, on the one ſide of *Ceylon*, and the great Gulfe of *Bengala*, (antiently *Sinus Gangeticus*) on the other, makes the place where the Pearls are fiſhed for, exceeding likely to be ſubject to very troubled *Seas*.

It will perhaps be thought no ſlight addition to the fore-going Arguments, if I here add, that meeting one day with an ancient and expert *Seaman*, whom his merit had advanc'd to conſiderable Employments in his Profeſſion, I was confirm'd by the Inquiries I made of him, not only in the Opinion I had about the Calmneſs of the Bottom of the *Sea*, but alſo that the operation of good Gales of VVind, does oftentimes not reach to near ſo conſiderable depths into the *Sea*, as

as hath been hitherto supposed, even by Navigators themselves. For he assured mee, that having sometimes sailed in great Ships that drew much water, as about 12 or 15 foot, he had Div'd to the Keel of the shipps, when they are under Sail, and observ'd the Agitations of the Water, to be exceedingly diminish'd, and grown very languid, even at that small distance, from the upper part of the Waves. And he farther answered, that when in *America* he learned to Dive of the Indians, they taught him by their Examples, to creep along by the Rocks and great stones, that lay near the shore at the Bottom of the Water, to shelter themselves from the strokes, and other ill effects of the Billows, which near the shore, and where the Sea was so shallow, as it was there, did often-hurt and endanger *S*wimmers and unskillfull Divers. But when they were by this means got further from *S*hore and into deeper VVater, they would securely leave the shelter they had till then made use of, and swim within a few yards of the *S*urface of the Sea, as fearing there no danger from the Tossings and Commotions of the upper parts of the Water.

But lastly, for further satisfaction, I had the opportunity to make inquiry about this matter of a great *S*ea Commander who has both an extraordinary curiosity to make marine Observations, & an unusuall Care in making of them accurately, I found the Opinion countenanced by his Answer, which was in short; That he had lately

been at a place where the *Sea* was often tempestuous enough, and that they found by a sure mark that the Storm did not reach with any efficacy four fathom beneath the *Surface* of the Water.

About the Tranquillity of the Lower Parts of very deep waters I had a suspition, which though I fear it might seem somewhat extravagant, because I have not met with it in Authors; yet I thought it worth examining for the use it might be of, if resolv'd in reference to the Ebbing and Flowing of the *Sea*.

I made therefore a *Solicitous* Inquiry whether the Tides did reach to, or near the Bottom of the deeper Seas, but found it exceeding difficult by reason of mens want of Curiosity to obtain any satisfaction about a Problem that most Navigators I have conversed with did not seem to have so much as dreamd of. But thus much I found indeed by inquiring of an *Engineer* who was curious of Marine Observations, that a famous *Sea* Commander of his Acquaintance being also a great Mathematician, had affirmed to this Relator, that he had divers times observ'd, that when he let down his Plummet to a great depth but yet not to reach ground, it would be qnickly carried by a motion quite cõtrary to that of the Shallop whence they sounded and very much quicker then it; but I had this only at second hand. Also, if I mis-remember not, I was informed by a skillfull Observer that commanded many of our English men

of

of Warr, that he had near the ſound obſerved the upper and Lower parts of the VVater to move with a conſiderable ſwiftneſs quite different wais; but not having committed this Relation to writing, I dare not build much upon it. And among the Anſwers I had received and written down concerning thoſe matters, all that I can yet find among my Adverſaria, is a Relation which though ſingle, will not be unworthy to be tranſcrib'd in this Place, becauſe the Perſon who gave it me, is one of the ancientſt and moſt experien'ſt Pilots of our Nation.

This Perſon therefore aſſured me, that ſayling beyond the *Cape of Good Hope* into the *South Seas*, made Tryalls of the motion of the upper part of the Water above the lower, where ſometimes caſting out a large and heavy Plummet, he let it down to ſeverall depths ſhort of 50 fathom, without any ſenſible Operation upon the motion of the Boat, or Shallop he ſtood in to make the Tryall; but when he let down the Plummet lower, to about an hundred fathom or more, then he found that though the Plummet reached not to the Bottom of the Water, yet upon the ſcore of the ſtanding water beneath, the Superior VVater would make the Boat turn towards the Tide or Current, as if it lay at Anchor, and the water would run by the ſide of the Boat at the rate of about three mile an hour, Thus far this diligent Obſerver. But how far the inequality of the Soil at the bottom of the Sea, and how far the various

various depth of the VVater, and ſome other circumſtances, may alter the caſe, and make it hard to determine, what ought to be aſcribed to Tides and what to Currents, and are things which I will by no means be poſitive in, till I can meet with further Information.

[*S*ince the writing of this, hapning to meet with one that ſpent ſome time at a famous Eaſterne Pearle-fiſhing, and asked him whether he had inquired of the Divers about the Problem lately propoſed, and whether the Sea were there deep enough to make obſervations of that kind: To the latter part of which Queſtion he replyed, that in ſome places it was of a very conſiderable depth, and fit to make the obſervation in; And to the former he anſwered, That he had inquired of the Divers, who affirmed to him that ſometimes at the Bottom of the Deep waters there ſeem'd to be a ſtagnation of the *S*ea for a great depth, ſo that till ſuch a height they could riſe directly upwards, but that at other heights they would be carried away by the leſſe deep-waters; ſo as to be found when they came to emerge a great way off from that point of the ſurface which was perpendicular to that place at the Bottom, whence they began to aſcend.]

FINIS.

Of the

TEMPERATURE

Of the

SUBTERRANEAL REGIONS,

As to *HEAT* and *COLD*.

OF THE TEMPERATURE, Of the SUBTERRANEALL REGIONS.

As to Heat and Cold.

CHAP. I.

IF when I uſed to viſit mines, I had thought of writing on the ſubject I am now about to treat of, and had deſign'd to ſatisfie my ſelfe about the Temperature of the Subterraneall Air, as much as I did about the other Subjects I was then concern'd to be inform'd of, I think I ſhould have enabled my ſelfe to deliver much more upon my own obſervation, then I ſhall now pretend to doe. But though for the reaſon newly intimated, and becauſe of my being particularly ſubject to be offended by any thing that hinders a full freedom of Reſpiration, I was not ſolicitous to goe down into the deep mines; yet after having diſcourſ'd of the Temperature of the Air above Ground, I preſume it may not be improper or unwellcome to ſay ſomething of the Temperature of the Subterraneall Regions and of

the Air reaching thither. For deep mines being places which very few have had the opportunity, and fewer have had the curiosity to visit, and of which I have scarce found any thing at all observable by Classick Authors, and by other writers, but very little, especially that I think probable enough to make use of, I presume it will not be unacceptable to you, if of Regions so little frequented, and less known, I report what I have been able to learn (by diligent enquiry purposely made) from the credible Relations of severall Eye-witnesses differing in nation, and for the most part unacquainted with each other.

Though I do not think it absurd to suspect that in some places of the Earth, the peculiar constitution of the Soil, and other circumstances, may make it reasonable to assign those places fewer or more Regions then three; yet speaking in the Generall, the Ternary number seems not inconvenient to be assigned to the Subterraneall Regions, not so much upon the score of the Analogy, that by this Division will be established between the Regions of the Earth and of the Air, as because there seems to be a reason of the Division included in the Division itself. And indeed Experience appears to favour it in the Subterraneall Cavity, that I have hitherto been able to procure an account of, from any Ocular witness, and (very few excepted) one of the deepest that we yet know of, in the world. And since it has been received for a Rule among Philosophers, that

that which is perfecteſt or compleateſt in its kind, ought to be the Standard whereby the reſt are to be meaſured, or eſtimated, I ſhall begin the remaining part of this Eſſay by a Relation that I obtained from a Chymiſt, that had purpoſely travelled into Hungary, and other places to viſit the mines thoſe parts are juſtly famous for, and who bringing me the honour of a Complement from a Prince, to whom he belonged gave me the opportunity of asking him divers Queſtions, his Anſwers whereunto (which I preſently after put into writing,) afforded me the enſuing account.

CHAP. II.

THat very near the Orifice of the Groove, he felt the Air yet warm; but afterwards deſcending towards the lower parts of the Groove, he felt it cold, till he came to ſuch a depth, as he had ſcarce attained by a quarter of an hours deſcent, and that the Cold he felt during this time ſeem'd to him conſiderable, eſpecially when in deſcending he had reached to a good depth.

That after he had paſſed that Cold Region, he began by degrees to come into a warmer one which increaſed in heat, as he went deeper and deeper. So that in the deeper veins he found the Workmen digging with only a ſlight garment over them; and the Subterraneal heat was much

greater, then that of the free Air on the top of the Groove, though it were then *Summer*.

[What is here mention'd of a cold region in the Earth, has been ſince confirmed to me by an ingenious Phyſitian, upon an obſervation made in another Hungarian mine (near a Town whoſe name I remember not) that was not of Gold, but Copper; and of much leſſer deepneſſe then that newly ſpoken of. For this Relator anſwer d me that in going down, he felt a conſiderable degree of Cold. And when I ask'd whether he found the like in his Return upwards, he told me, he obſerv d it then too. And when I further inquired after the extent of this cold Region, he replyed, that not expecting to be ask'd about ſuch Circumſtances, he had not taken particular notice of them: but thus much Information my Queſtions procur'd me, that he began to feel the above mention'd coldneſſe when he could receive no more light at all by the mouth of the Groove, and that this cold Region laſted till he came ſomewhat near the bottom, which was eſtimated to be about an 100 fathom or more diſtant (in a ſtrait Line) from the Top.]

This Relation agrees well enough for the main, with that ſhort, but conſiderable one of *Morinus*, (which I elſewhere cite) who above forty five years agoe, viſited the deep Hungarian-mines in the month of July, and takes notice, that when he came down to the burrows, as he calls them, he did not find any heat, as at the mouth of the

Wel

Well; but the beginning of a very Cold, as well as considerably thick Region: though I easily beleive him, when he confesses, that he felt it much the Colder, because he had left of his own Clothes, and put on the slight Garments used there by the Diggers. He further informs his Reader, that when they had descended about 80 fathoms beneath the surface of the Earth, he began to feel a breath of an almost luke-warm air; which warmth increased upon him, as he descended lower, pleasing him not a little, because it freed him from the troublesome scents of his former coldnesse. Adding that the Overseer of the mine who conducted him, affirmed to him, as also the Officers of other Hungarian mines unanimously did, that in all their mines, at least all the deep ones, after a thick tract of Cold Earth, there succeeds a Lower Region, that is alwaies hot. And that after they arriv'd at such a depth, they felt not any more Cold, but alwaies Heat, how deep soever they digg. And to add upon the by, though this Learned Man lay much weight upon *Antiperistasis*; yet in the next page to those that contain what I have been just now relating, he either very candidly or inconsiderately takes notice, that they inform'd him, that their mines, whether more or lesse deep, they observed that at some times in the year, a somewhat intenser heat was felt, and the two Times that he expressly names, are those oppositely qualified Seasons of *Summer* and *Winter*.

Having laid down these generall narratives; I now proceed to consider the Earths Regions in particular, about which the Summe of what I yet have to propound, may be conveniently enough compriz'd in the 4 following Propositions.

CHAP. III.

Proposition the 1.

THe First Region of the Earth is very variable, both as to Bounds, and as to Temperature.

The former part of this observation will not be difficult to prove, since 'twill be easily granted, that the manifest operation of the *Sun-Beams* is (*cæteris paribus*) greater, and reaches further in hot Climates then in Cold ones; in the midst of *Summer*, then in the depth of *Winter*.

The Second part of the Observation may be proved by the same Arguments as the First; to which may be added, as to some places, the Solidity or porousness of the Earth, as also the nature of some Salts, Marchasites, and other Bodies contained in it, which by their natural Temperature may dispose the Soil to Coldness or Heat. As I shall have occasion to shew, when I come to speak of the second Region.

In the mean time I have this to observe further, That in this First Region, the Air is usually more temperate, as to Cold and Heat, then that above

above the ſurface of the Earth, and that this Region is not wont to be conſiderably deep: Both parts of which Obſervation are capable of being made good by the ſame Reaſons, and therefore I ſhall endeavour to prove them jointly.

That in the uppermoſt Region of the Earth, it ſhould be leſs cold then above the ſurface, ſeems reaſonable to be allowed upon this Conſideration, That the *Subterraneall Cavities* of the Earth are ſheltered by the thickneſs of the ſides, from the direct action of the *Sun*-Beams, the Winds, &c. and is alſo kept from an immediate, or at leaſt from ſo full a contact of the externall Air, when that is vehemently, either heated or refrigerated.

And firſt as to the heat of the Sun, that That does much leſs powerfully affect ſuch places as are ſheltered from its action by ſolid Bodies, may appear by the Conſervatories of Ice and Snow, wherein frozen water is kept in that State during all the Heat of *Summer*, and that oftentimes in Cavities that are at no conſiderable depth beneath the Superficies of the Earth. Nay I remember that having had occaſion, (for the perfecting of ſome Concluſions I was trying) to keep Ice many weeks after the froſty Weather was gone, and a milder Seaſon was come in, I was able to doe it, (contrary to the expectation of ſome Curious men,) without either digging to a notable depth in the ground, or building any ſubſtantiall *Structure* over the Cavity. For wanting

ting conveniencies, I contented my selfe (though 'twere in a champain place) with a pit somewhat broad at the bottom, of about four foot deep or lesse, whose mouth was shelter'd only by a little low thatch'd hovell, that was wide open to the *North*, and only skreen'd the mouth or vent of the little pit from the direct Beams of the Sun. And though I will not deny, that in deep Conservatories of Snow, the naturall Coldnesse of the Earth, especially in some places, may contribute to the effect; yet I remember, that discoursing once with a Traveller and Schollar that was born in hot Countries, of a conjecture of mine that in an arch'd building, whose walls were sufficiently thick, and whose Air were carefully kept from all avoidable intercourse with the externall Air, one may without digging so much as a mans depth into the Ground, make a sufficient Conservatory for Ice in very open and unshelter'd places, and even such as *Salisbury plain* it selfe; discoursing (as I began to say) with this Traveller about this Conjecture, he told me, that at a place he nam'd to me, in the Southern part of *France*, whose heat seem'd to me to exceed that of divers parts of *Italy*, some Curious persons that were resolv'd at any rate, to have Ice in *Summer*, though the *Soil* were such, that they could not dig 4 foot without meeting with water, were yet able to make use of Conservatories by covering the Brick-Building they made over their pits, with *Clay* and *Sand* to a very considerable thicknesse

thicknesse, and taking care that the only place that should permit accesse to the outward Air, should be a small Northern Door to go in and out at, fitted to shut exactly close, and fenc'd with a little porch furnished with another Door. And by this means he affirms these Gentlemen to reserve the included Ice not only all the *Summer* long, bnt sometimes for two or three years together, the heat of that Region making many of their Winters too mild to recruit them with Ice.

To all these things I shall add, that even where the intercourse is not quite debarr'd, but left free enough betwixt the Subterraneall and the superior Air, the operation of the Sun-Beams may be very much lesse in a Cavity though but shallow, beneath the Surface of the Ground then above it. For besides that Tryalls have inform'd me, that Liquors that differ in little else then in consistence, will not so easily pervade each other, as a man would surmise; unlesse some externall motion hasten their intimate mingling with one another. I remember that one morning pretty late, having had the Curiosity to descend into a pit where they were digging out Iron Oar; though this Cavity had no very narrow Orifice, and was dugg directly downwards, and exceeded not ten or twelve foot in depth: yet I found not the heat at all troublesome whilst I staid there, Though the pit were in an open feild unshaded by Trees, and though the Air abroad were much heated

heated at that time of the year, which was in that ſeaſon (or at leaſt very near it) that is wont to be call'd the Dogg-Daies.

CHAP. *IIII.*

AND as we have ſhewn, that the Subterraneal Air, even in the firſt Region is uſually much leſs heated, then the *Superterreſtriall Air*; ſo we may alſo eaſily obſerve, that That Inferior Air is (*Cæteris paribus*) wont to be much leſs refrigerated by the grand Efficients of intenſe Cold, then the *Superior Air*.

I will not urge on this occaſion what I have obſerved by a ſurer way, then for ought I know has been before practiſed, about the ſmoaking of ſome *Springs* in *Froſty Weather*; becauſe I doe not know but that thoſe *Springs* may have come from, or paſſed a good way through, ſome place very deep beneath the Surface of the directly incumbent ground, and perhaps from a Soil peculiarly fitted to warm them: whence the water may have deriv'd a warmth conſiderable enough not to be quite loſt, till it began to ſpring out of the ground, where it needed only not to be quite Cold to appear to ſmoke; the intenſe Coldneſs of the Air making thoſe exhalations viſible in *Froſty Weather*, which would not be ſo in milder: As is evident in a mans Breath, which appears like a ſmoak in *ſuch weather*, though it be not viſible in *Summer*. That

That therefore, which I shall propose in favour of our observation, is first taken from the nature of the thing, which may perswade us, that the *Subterraneall Air* being though comparatively cool, yet indeed moderately warm in *Summer*, ought not to be affected with Winters Cold, so much as that contiguous to the *Surface* of the Earth, from whose immediate Contact, it is by a thick arch of Earth (if I may so call it) defended; and that the Cold reigns most in the free Air; and the *Superficiall* parts of the Terrestriall Globe, may appear by Waters beginning to freeze at the Top, not at the Bottom. To which Reason from the nature of the thing, I shall add only this from experience, that we see that in Cellars that are arch'd and carefully kept close from the Communication of the outward Air, Beer, and other Liquors may be kept from freezing in frosty, and snowy Weather. As I have observed in a cellar that was but shallow, but well arch'd in a *Winter* that was sharp to a wonder, and froze stronger Liquors then Beer in another Cellar very near it, that differed not much from it in depth, but had not so thick and solid a roof. And that not only here in *England*, where the Cold is less violent, but even in *Russia* it selfe, where it is wont to be so extream, it reaches not near so deep as one would think, I learn'd by Inquiry purposely made of an ingenious Physitian that lived at *Mosco*, who answered me, that others and he himselfe, did in that City keep all

the

the Winter long, not only their Wine but their Beer from freezing in Cellars that were not above 12 or 14 foot deep, but well cover'd above, and carefully Lin'd with plankes of Firr, without any entrance, but a ſmall trap-Door (commonly at the top,) which was fitted ſo exactly to the Orifice it was to cloſe, as to exclude (as much as was poſſible) all communication between the internall and externall Air, that the latter might not affect the former with it's Coldneſſe.

I have indeed ſuſpected that in ſome Cellars, the comparative warmth we find there, may be partly due to Subterraneall Exhalations that are pent up in them: and perhaps too in ſome meaſure from the Steams of the fermenting, or fermented Liquors lodg'd in thoſe places. And I was ſomewhat confirmed in this Suſpition, by an Information my Inquiries obtained from the newly mentioned Doctor, who told me upon his own obſervation, that in one of the Cellars he made uſe of at *Moſco*, having occaſion to open the above mentioned trap-door, after the Cellar had for a good while been kept very cloſe ſhut, there came out at the vent that was thereby given, a copious Steam in the forme of ſmoak, which to them, who had their Bodies affected with the externall Air, was very ſenſibly warm, and was almoſt unfit for Reſpiration. Which Circumſtance increaſed my ſuſpition that there might be among theſe ſteames, ſome of the nature of thoſe, that

that have been obſerved to come from fermenting Liquors, eſpecially Wine, and ſo abound in ſome Cellars, as almoſt to ſtiffle thoſe that ventured into thoſe Vaults, And to kill ſome of them outright. Which effects the long abode of Subterraneall *Steams* in ſtagnating Air, even in many places, where no metalline Oars at all, nor other noxious mineralls have been found, has enabled that Air to produce. Of which divers ſad Inſtances have beengiven within leſſe then a mile of this place, upon mens firſt going down into pitts or Wells, that had not in a long time been open'd or made uſe of: (but this is here mentioned only upon the By) nor have we any neceſſity to fly to *Subterraneall Exhalations*, for the Comparative warmth that good Cellars in generall afford in froſty weather; ſince that *Phænomenon* may be accounted for, by the reaſon formerly given, That the cloſeneſſe of the Cavity, and the thickneſſe of the ſides and Roofe, keep it from being vehemently affected with the Cold of the Ambient Air.

I know 'tis pretended that the warmth we ſpeak of, proceeds from an *Antiperiſtaſis*, but not now to engage in a controverſy that would take up too much time, it may here ſuffice to repreſent, that in our caſe there appears no neceſſity of recurring to it, the *Phænomenon* being ſolvable by the Region newly cited; which may be confirmed by this Experiment, that in the Vaulted Cellar above mention'd, wherein Beer was kept from freezing,

in

in an almoſt prodigiouſly ſharp Winter, the included Air, though ſenſibly warm, to thoſe that came out of the free Air, had not ſo intended its native heat, as the Aſſertors of *Antiperiſtaſis* would have expected; being Colder then the free Air commonly is in that place, not only in the heat of *Summer*, but in other ſeaſons, when the weather is Temperate; As I was aſſur'd by comparing my own obſervations made at other times, with the account brought me by a skilfull perſon, whom I employ'd into that Cellar at late hours, in one or two of the ſharpeſt nights of the forementioned cruell winter with the ſame excellent ſeal'd weather-glaſs that I had long kept ſuſpended within a ſtones caſt of that place.

CHAP. V.

HAving ſaid thus much about the Earths uppermoſt Region, I now proceed to that which lies next beneath it; whoſe Temperature I cannot ſo conveniently give an account of, in leſs then two Propoſitions, whereof the Firſt is this;

Propoſition the firſt.

The Second Region of the Earth ſeems to be for the moſt part cold in compariſon of the other two.

This propoſition may be confirmed partly by Reaſon, and partly by experience.

And

And first it seems consonant to Reason, that since the Earth is naturally a Bodie consisting of gross and heavy parts, that are *usually* much lesse agitated, then those of our Organs of Feeling, it should as to sense be cold; and that therefore that quality may be justly ascribed to it, in that Region where by vertue of its situation, it is kept from being considerably affected, either by the heat of the Superior Air, or by that of the deep parts of the Earth: which upper, and lower heat are the two Agents, that seem of all others the most likely to put its parts into an unusuall motion, and thereby change its naturall Temper.

That our proposition is also confirmable by Experience, may be gathered from the Relations set down in the former part of this discourse,

And here it will be proper to take notice of the Advertisement intimated in the close of our above delivered proposition, That this Coldnesse ascrib'd to the second Region of the Earth, is to be understood comparatively to the other two. For otherwise that even this Earth is not (as many naturallists would have it) the *Summum Frigidum* I gather from this, That I could never hear of any Ice met with there, at any time of the year though *Snow* or *Hail* may be produced in the middle Region at differing, and sometimes quite opposite seasons of the year; nay, I have not found by the Answers that were made me by those that have descended far enough into this Region, that they found the cold any where very great, or that

in some places they have found it at all considerable. As we shall see in the explication of the next proposition. I know not whether it will much strengthen what has been said, if I add, that I learned by inquiry of such persons as I lately mentioned, that at the mouth of deep Grooves, in mines, the steams that ascend, do often feel warm; though the outward Air where the Observation is made, be affected with the heat of *Summer*. But *though* this *probably* argue, that if the middle Region of the Earth, through which these Steams must ascend, were very intensely cold, they would be so refrigerated in their passage, as to feel rather Cold then hot at their appearing above ground, especially in Summer: yet I shall not lay much weight (for some may perhaps be allowed it) upon this Argument; because I have not yet tryed, how far a warm Steam may be alter'd in its passage, thorow a Cold Conduit: not to mention that in the Earth, the passage by being directly upwards may be much the nimblier traversed.

CHAP. 6.

THe second proposition relating to the Temperature of the second Region of the Earth, may be delivered in these Terms.

Proposition the 3

In several all places, which by reason of their distance

ſtance from the ſurface of the Earth, one would refer to the middle Region of it, The Temperature of the Air is very differing at the ſame times of the year

I choſe to expreſs my ſelfe thus, to prevent ſome ambiguities and objections which I foreſaw, that ſhorter, but leſs dear and full expreſſions, might give occaſion to.

In the proofe of our propoſition, both Experience and Reaſon may diſtinctly be employed. And to begin with experience,

Whereas in the above recited deſcent into the *Hungarian-Mines*, there was obſerved a notably Cold Region of a conſiderable thickneſs, I have purpoſely procured accounts from divers perſons that have here in *England* had occaſion, ſome of them frequently to deſcend into deep pits or Grooves of differing mineralls, without finding by the narratives they made me, that they took notice of any notably cold part that they paſſed thorow; unleſs I particularly asked a queſtion about ſuch a thing. But for ought I could gather from their Spontaneous Relations, they felt in *Summer-time* a remiſſion of the heat of the externall Air, aſſoon as ever they began to deſcend; which warmth did not ſo far decreaſe, as to terminate in any notable Coldneſs, before they came into a deeper part of the Earth, where they are never troubled with that quality. And ſome of theſe Relations I had from profeſſed Miners, and was curious that the Relations I procured ſhoud

be of *Subterraneall parts* seated in very differing parts of *England*, as well as of places not all, or most of them having Veins of one and the same minerall. And I learned by particlar inquiry from a practicall Mathematician that was often employed about Lead-mines that at such depths as, (according to *Morinus*) the second Region of the Earth reaches to, he himselfe observed it to be sensibly warm at all seasons of the year (for about that Circumstance I was peculiarly solicitous to be satisfied.)

Nor is it unconsonant to Reason, that the middle Region of the Earth, in the sense meant in the proposition, should not be of the same temperature in all places; not only because of the differences, which the Climate may produce, by reason of its being very much hotter, or very much colder in one place then in another: but from the peculiar constitution of the *Soil*; to the Consideration whereof I shall here confine my selfe.

Now this Temperament of the Soil it selfe may be divertified, not only by its greater or lesser compactnesse (upon which account some *Soils* are Rocky or stony and others Light and spongy) but from the nature of the springs or Subterraneous Liquors, that may abound in it, or strain through it into the Groove or pit, we suppose the Observer to be in; and that especially by the minerals, particularly Salts, and Marchasites that grow near the sides of the Well, or are brought thither by the waters.

To

To illustrate this, give me leave to consider, that nature dos not regulate her selfe under ground by our imaginary Divisions: but, without taking notice of them, produces marchasites, Salts, and other mineralls, most frequently (perhaps) in what we call the lower Region of the Earth; but yet sometimes to, in our upper Region and oftentimes in our middlemost Region. Let us then suppose, that in some places of this last nam'd Region, there be a mine of that Earth that naturally abounds with embryonated nitre, or with some other salt that is apt, especially being dissolv'd or moistened with water, (a thing very familiarly to be met with in mines; to send out a refrigerating Effluvium, or by its contact to cool the Air. Let us also suppose that by the sides of another Well of the same depth, there are store of unripe mineralls that are in the process of generation, or rather a great quantity of marchasiticall Earth, if I may so call it, that is such a substance, as I have met with, in more then one place, copiously impregnated and as it were blended with mineralls of a marchasiticall nature; and yet of so open and loose a Texture, as not only water would in a few hours, but Air also would in not very many, evidently worke upon it. And since during the time that marchasites are slowly dissolving, it has been observed according to what we have elswhere delivered * that many

* *The Tract here pointed at is a Discourse of Subterraneall Fires and Heats.*

many of them will conceive a very considerable degree of heat, will it not be very probable, that the Temperature of the Earth in the place that abounds with these Marchasiticall mineralls will be very warm in comparison of the Temperature of the other place, where the Soil dos plentifully produce nitrous, and other refrigerating Bodies; though both the places be supposed to be at the same distance from the surface of the Earth, and consequently in the same Subterraneous Region.

Upon the like grounds, it may also be suspected, that in the same places the Temperature may not be alwaies the same, even upon the account of the Soil. For I elsewhere shew, that some Saline Earths, especially nitrous, and some mineralls that partake of the nature of marchasites, admit a kind of graduall maturation, and perhaps other Changes that seem to be spontaneous. And that such changes happen the more notably in those parts of such Bodies that are exposed to the Air, as those are that chance to be placed at the sides of the deep Wells we are talking of. Which things being presuppos'd, 'twill not be absurd to conceive, that the minerall, to which either heat or cold is to be referr'd, may be more copious, ripe, and operative at one time, then at another; or that at length, all the Earth capable of being, as it were Assimilated by the minerall rudiments harbour'd in it, may be consumed, or the minerall it selfe may arrive at a perfection

of

of maturity, which will make its texture so close as to be unfit to be penetrated, and wrought upon; as before, by the water or other Liquor that occasioned its incalescence.

CHAP VII

I Omit to speak of the transient changes that may be occasion'd in the temperature of the second Region of the Earth by severall Accidents, and especially by the Subterraneall Exhalations, that in some places and times copiously ascend out of the lower Regions of the Earth. Nor shall I insist upon any of the other causes of a more durable difference of temper in some parts of the second Region, such as may be the Vicinity of Subterraneall Fires in the third Region that heat the incumbent *Soil*; because I would hasten to the Third and last part of this Discourse: which yet I must not do without premising this advertisement, that I think my selfe oblig'd to speak the more hesitantly and diffidently about the Temperature of Subterraneall Air; because mineralists have not had the Curiosity to examine it by Weather-glasses, which would give us much more trusty Informations then our sense of feeling powerfully preaffected by the cold or heat of the externall Air. I did indeed send fitt Instruments to some daies journey from this place, to examine the Air at the bottom of some of our

deep mines: but through ſome unlucky caſualties upon the place, the attempt miſcarried. But when I ſhall (God aſſiſting) recover an opportunity that I have ſince wanted, I hope an accurate *ſeal'd Weather-glaſſe*, join'd with a portable Baroſcope will give me better Information then mineraliſts have yet done. I ſay a ſeal'd Weather-glaſſe becauſe though common Thermoſcopes had been employed by miners, I durſt not rely upon them; being perſwaded by tryalls purpoſely made, as well as by the Reaſon of the thing, of the Fallaciousneſſe of ſuch Thermoſcopes: for in them the included Air is liable to be wrought upon, not only by the Heat and coldneſſe, but by the weight or Preſſure of the externall Air. So that if a Thermoſcope be let down from a very conſiderable height, at the top of which the ſtation of the pendulous Liquor be well markt, that Liquor will be found to have riſen, when the Inſtrument reſts at the bottom, as if the included Air were manifeſtly refrigerated: though the temper of the externall Air may be in both places alike, the cauſe of the pendulous Liquors riſing being indeed that the Aereall pillar incumbent on the ſtagnant Liquor, is higher and heavier at the bottom, where the Inſtrument reſts, then that which lean'd upon it, at its firſt or upper ſtation nearer the top of the Atmoſpher. From whence 'twill be eaſy to'conclude that at the bottom of a deep Groove, where the Atmoſphericall pillar that preſſes the ſtagnant water

water will be much longer and heavier then at the top, the Air may appear by the Instrument to be colder in places, where 'tis really much hotter, the increased weight of the incumbent Air being more forcible to impell up the pendulous Liquor then the indeavour of expansion procur'd in the included Air by the warmth of the place is to depresse it.

CHAP. VIII.

THat which challenges the third and last part of my discourse, is the lowermost Region of the Earth, about whose temperature I shall comprize, what I have to say in the following Proposition.

Proposition the 4.

The third Region of the Earth has been observ'd to be constantly and sensibly warm, but not uniformly so; being in some places considerably hot

I mention that the recited temperature has been observed in the Lower Region, because I would intimate, that I would have the proposition understood with this Limitation, as far as has been yet (that I know of,) observed. For allmost all the deep Grooves that mineralists have given us accounts of, and wherein men have wrought long enough to take sufficient notice of the

the Temperature of the Air, have been made in Soils furnished with metalline Oars, or other mineralls, without which, men would not be invited to be at so great a charge, as that of sinking so very deep pits, and maintaining work-men in them: So that experience has yet but slenderly, or at least not sufficiently informed us of the Temperature of those parts of the third Region of the Earth, that are not furnished with ponderous mineralls, and consequently has not informed us of the Temperature of the Lowermost Region in generall; as will better appear by what I shall ere long represent.

Having premised this Advertisement about our proposition, we may proceed to the distinct proofe of the two parts or members it consists of.

And to begin with the first, whatever the Peripateticks teach of the innate Coldnesse of the Earth, especially where 'tis remotest from the mixture of the other Elements; yet having purposely inquired of severall persons that visited and also frequented the Third Region in differing Countries, Soils, and at differing depths under ground, and Seasons of the year, I did not perceive that any of them, had ever found it sensibly and troublesome cold in the Third Region of the Earth. And on this occasion I remember I had some light suspition, that, (at least in some Cases) the narrowness of the Cavities wherein the Diggers were in divers places reduc'd to worke, might make

make the warmth they felt, proceed in great part from the Steams of their own Bodies, and perhaps of the mineralls, and from the Difficulty of cooling or ventilating the Blood in an Air clogg'd with ſteams. And I was the rather induced to thinke this poſſible, becauſe I had (even in metalline mines that were but ſhallow and very freely acceſſible to the Air) obſerved a ſtrong ſmell of the metall abounding there.

I have likewiſe found by ſeverall tryalls, that the exhalations that proceed from the Bodies of Animalls, doe ſo vitiate the Air they abound in, as to make it much leſs fit for their Reſpiration, and to be apt to make them ſick and faint. Wherefore I thought it not altogether unfit to inquire, whether the heat of the Subterraneall air, in ſuch places as have been newly mentioned, might not be referr'd to theſe Cauſes? But I was anſwered in the negative; eſpecially by an inquiſitive perſon that had been in the deepeſt and hotteſt mines that have been viſited by any Acquaintances of mine.

This way of accounting for the Subterraneall Warmth being laid aſide, it ſeem'd I confeſſe ſomewhat difficult to conceive how it ſhould be produced; yet two principall Cauſes there are to which I thinke we may probably refer the Temperature of thoſe places, where the air is but moderately warm. To which a Third is to be added; when we come to give an account, why ſome places are troubleſomly hot.

And

And first, why the Coldneſſe of Winter ſhould not be felt in the Lowermoſt Region of the Earth may be, that the air there, is too remote from the Superterreſtriall air, to be much affected with thoſe adventitious Cauſes of Cold, that make that Quality intenſe in the air above ground. But becauſe this Reaſon ſhews rather, why it ſhould not be in the Earths Lower Region much Colder in *Winter* then in *Summer*; but not why it ſhould be in all ſeaſons warm there, I ſhall add as a Conjecture, that the poſitive cauſe of the actuall warmth may proceed from thoſe deeper parts of the Subterraneall Region, which ly beneath thoſe places which men have yet had occaſion and ability to dig. For it ſeems probable to me, that in theſe yet inpenetrated Bowells of the Earth, there are great ſtore-houſes of either actuall Fires, or places conſiderably Hot, or, (in ſome Regions) of both; from which *Reconditories* (if I may ſo call them) or magazines of hypogeall heat, that quality is communicated, eſpecially by Subterraneall Channells, Clefts, Fibres, or other Conveyances, to the leſs deep parts of the Earth, either by a propagation of heat through the ſubſtance of the interpoſed part of the Soil. (as when the upper part of an Oven is remiſsly heated by the ſame Agents that produce an intenſe heat in the Cavity,) or by a more eaſy diffuſion of the Fire or heat through the above mentioned Conveyances as may be exemplified by the pipes that convey heat in ſome Chymicall

micall ſtructures:) Or elſe, (which is perhaps the moſt uſuall way,) by ſending upwards hot minerall Exhalations and Steams, which by reaſon of the comparatively heavy materialls they conſiſt of, and by reaſon of their being leſſe diſperſed nearer the places whence they proceed, are uſually more plentifull in the deeper parts of the Earth, and ſomewhat affect them with the Quality that they brought from the workhouſes where they were form'd and that they retain for ſome time after.

CHAP. IX.

THat manifeſt Steams oftentimes are found in Grooves, eſpecially in deep ones is evident, by the damps that infeſt moſt of them, and that in diſtant Regions, as in ſeverall provinces of *Germany*, *Bohemia*, *Hungary*, &c. as alſo in ſeverall parts of *England* in Grooves, ſome of which I have received Relations from the mine-men themſelves. By which it appears, that ſeverall of theſe Exhalations aſcending from the entralls of the Earth are ſulphureous & Bituminous in ſmell and in ſome Grooves (one whereof I elſewhere mention my ſelfe to have viſited) theſe Steams are apt, actually to take fire.

The warmth of many Subterraneall Exhations I thinke may be made further probable by ſome other Obſervations. For though theſe newly mentioned

mentioned are not to be rejected, and may be employed for want of better; yet I have severall times questioned, whether I ought to acquiesce in them alone. For I do not thinke the easy inflammableness of Bodies to be alwaies a sure proofe of the actuall sensible warmth of the minute parts it consists of, or may be reduced into. For though Salt-peter be very inflammable, yet being by a solution in fair water reduced to invisible Corpuscles, it highly refrigerates that Liquor. Nor have I observed its fumes, (when far from the Fire,) to have any heat sensible to our Touch. And the like may be said of the *Exhalations* of highly rectifi'd spirit of Wine; which yet we know is itselfe totally inflammable. Nay I know not whether, (for a Reason elsewhere declared) copious Exhalations may not ascend from the lower parts of the Earth, and yet be rather Cold then Hot. For (in another Paper) I mention a way by which I made a mixture that plentifully enough emitted Steams, of whose being rather of a Cold, then hot nature, there was this probability, that the mixture whence they ascended even whilsts its component Ingredients were briskly acting upon one another, was not only sensibly, but considerably Cold.

One main thing therefore that induces me to assent to the Opinion, whereto the former Instances do but incline me, is, That having purposely inquired of an observing man that frequented deep mines, (wherein he had a considerable share,) he

he answered me, that he plainly observed the fumes that came out of the mouths of the deep pits, to be actually and sensibly warm, and that in a warm season of the year. And *Morinus* (above cited) speaking of the deep *Hungarian-mines*, makes it the first Epithite of the copious Exhalation that ascended from the bottom, that it was *hot*. And a few pages after he says, that at the mouth of the Well, the ascending Fumes were *sensibly hot in Summer it selfe*. And the same Arguments that I have elsewhere given to shew that there are very hot places, and as it were Æstuary in the Bowells of the Earth, may serve to make it probable that the steams ascending thence may be actually warm.

That also in many places of the Earth, where no Grooves are dugg, and no visible Exhalations are taken notice of, they may yet pervade the Soil, and exercise some operations of warmth, may be probable by this, that the experienced *Agricola* himselfe reckons it among the signs of a latent minerall vein, that the hoar-frost does not ly upon that tract of the Surface of the Earth, under which a vein (though perhaps very deep) runs. The like Directions I have known given by the skillfull in *England*, for the Discovery of places that contain Coal-mines. And I remember a near relation of mine shewed me a great scope of Land of his, which (though in an outward appearance, likely to be as cold as any place thereabouts,) he affirm'd would not suffer Snow to ly upon

upon it above a day or two in the midſt of *Winter*.

The probability of which Relation was confirmed to me by the anſwer I received from a very ingenious Gentleman who lives among mines, and is not a little concern'd in ſome of them. For having inquired of him, What he had obſerved about the lying, or not lying of the *Snow* on the minerall Soils near the place of his Reſidence; he replyed, that in ſome of them, he did not take notice of any peculiar Indiſpoſition to let the Ice and Snow continue on them: which I conceive may proceed, either from the want of ſuch minerals in the Subjacent parts, as were then in the ſtate of Incaleſcence; or elſe from this that, (according to what we have elſewhere obſerved about the Snows on *Ætna*) the direct aſcenſion of the hot Steams was hindered by ſome Layers of Rocks or other Stone, through which the Steams could not penetrate, or could doe it but ſo ſlowly, as to looſe their actuall warmth by the way. But this Gentleman added that in other places, near that of his abode, and ſuch as he knew to have minerall-Veins beneath them, he obſerved that the Snow, (nor the Ice) would ſcarce continue at all upon the Surface of the Ground, even in an extraordinarily cold winter.

It will be a conſiderable Inſtance to our purpoſe if it be indeed true which ſome learned men have written that near the Gold-mines in Hungary

gary the leaves of the trees, (especially those that respect the Ground) are oftentimes found ennobled with a golden-colour from the metalline Exhalations of the Gold-mines: which one would think must by reason of their ponderousnesse need a considerable heat to elevate them, especially into the open Air. But though doubting of this Relation, as not made by mineralists or accurate Observers, I inquired about it of a person, whose Curiosity carried him purposely to visit those mines; I was answer'd that he could not be a witnesse to the truth of the Observation; yet he told me, an observation, (which *I* elsewhere mention) that doth not discountenance that Tradition.

If it be objected that what has hitherto been said about Latent Fires and heats in the Bowells of the Earth will give an account of the warmth only of those places that are within reach of the action of such Magazines of heat, which probably may be wanting in many places of the Earth; I shall readily confesse, that as I first made this Objection to my selfe, so I do not yet discern it to be unreasonable, and that for ought I know if men had occasion to digg as deep and be as far conversant in many other low places of the Earth, where there are no signs of Mineralls, as they have done where the hopes of actuall discovery of veins of metalls, and other mineralls worth working, have invited them, divers places in the Third Region of the Earth would be met with, that would

bedestitute of the warmth that has hitherto been generally found in places of the same Regionthat either abound with mineralls themselves, or are near some of the deep and latent Æstuaries above-mentioned.

And as for those parts of the Third Region of the Earth, which men feel not only warm, but troublesomly hot, that incommodious degree of heat seems not, (at least in some places) to be derivable from the two above mentioned causes; which must, (to produce so considerable an effect) be assisted by a third cause more potent then themselves: which seems to be the incalescence there is produced in many mines, and other Places, by the mutuall action of the component parts promoted by water of immature and more loosely contexed mineralls, especially such as are of a Marchasiticalll nature. That such an Incalescence may by such a way be produced in the Bowells of the Earth, I have elsewhere shewn (in my discourse of Subterraneall Fires & heats) by the examples of such incalescences producible in minerall Bodies here above ground. That Marchasites which for the most part abound in Vitrioll, are bodies very fit to procure this Subterraneall heat, may be confirm'd not only by the Sulphureous and Saline parts they abound with, and by this, that many of them may be wrought on, as we have tryed, both by simple water, and even by moist Air, which argues the resolubleness of their Constitution: but also by this,

this, that having purposely inquired of a Gentleman that went out of Curiosity to visit one of the deeper Hungarian-mines, he confirmed to me what I had otherwise been informed of, by answering mé, that in the lower parts of the mine, he had gathered Vitrioll that appeared above ground to be of a golden nature; and that in a Cave that is on one side of the Groove, in the deep Gold-mine near *Cremnitzo*, the corrosive smell is so strong and noxious, that men have not dared to dig out the native Gold it richly abounds with, being deterr'd by the ill fate of divers that ventured to work in it. Adding that though he passed by it, in great hast; yet he could not avoid the being offended by the noysome Exhalations. And on this occasion, 'twill not be (I presume) disliked, if I illustrate what I was saying of Immature mineralls, by subjoining, That having, asked this Chymist whether the Vitrioll he found very deep underground were all solid, or some of it soft? he affirm'd that as he gathered it, he found some of it soft. And to satisfy my curiosity to know whether it continued that yeilding consistence? he further told me, that it was soft in the deeper part of the mine, but when he had brought it into the Superterrestriall Air, it hardened there and appeared to have 9 divers golden streakes in it.

CHAP. X.

ONe thing there is, which must not be here omitted

omitted, though it will probably be great news to those that philosophize only in their studies, and have not received information from any that visited the deeper parts of the Earth: The *Phænomenon* is this, That the Diggers in mines having found by unwelcom experience that in deep Grooves, the Air (unless ventilated and renewed) dos in a short time become unfit for respiration, have been put upon this expedient, to sinke at some convenient distance from the Groove where the miners worke, another pit (by some called a vent pitt) that usually tends directly downwards (though sometimes it make Angels) to which our English-minemen do in severall parts of this Kingdom give differing names; whereof the most significant seems to be that given it in the Leadmines of *Darbyshire*, where they call it an *Air-shaft*, and are wont to make it 40, 50, and sometimes 80 or 100 paces off, and, (as one of the cheife and skillfull Miners there informed me) as deep as the Groove or Well; (Though I find that the best *German* and some *English Miners* think a less depth will often suffice) From this Air-shaft to the Groove the men work in, there passes a Channell or if I may so call it, *Ventiduct* to convey the Air from the former to the latter; which is that, that *Agricola* sometimes (for he employs not the Terme alwaies in the same sense) denotes by his *Cuniculus*; and which though differingly nam'd by our Miners in severall parts of England

Lib V. & VI. De re metall.

is in the above mentioned Lead-mines called a *Drift*, because the Air dos usually in the form of Wind drive thorow it: and thereby enables the Workmen to breath freely and conveniently enogh at the very bottom of the Well. On this occasion I remember that a very observingrman who much frequented these Mines told me, that at the depth of no less then about 200 yards, he found that by the help of the Air-shaft, the Air was not only very commodious for Respiration, but temperate as to heat and Cold. And when I further asked, what time of the year it then was? he told me 'twas about the latter end of *August* and the beginning of *September*.

Now that which seems ro me to deserve a fartherand accurate observation about the motion and Temperature of the Air in these Artificiall under ground Cavities, is a Relation of *Agricolas* which, (though he be the most Classick Author we have about mines,) has not (that I know of) been taken notice of, in him. For this experienced VVritter, though in his Treatise * *de Ortu & causis Subterraneorum*, he only sayes indefinitely, that by means of the *Cuniculus or Drift*, which connects the Air-shaft & the well, that Air which comes in at one of those two, passes out at the other; yet in his Fifth Book

Idcirco fcrobes, putei cuniculi effossi complentur exteriore Aere. Atque ipsum in eos influere imprimis hyemali tempore evidens est in duobus puteis, ad quorum utrumque ex modico intervallo cuniculus aliquis pertinet. Nam Aer in unum continuo influit rectâque per cuniculum permeat & transit ad alterum; atque ex eo rursus evolat foras.

de

de re metallicâ he gives a more particular and odd account of the course of the Air in these not over clear Terms, *Aer autem exterior se suâ sponte fundit in cava terræ, atque cum per ea penetrare potest, rursus evolat foras. Sed diversâ ratione hoc fieri solet; etenim vernis & æstivis diebus in altiorem puteum influit, & per cuniculum vel fossam latentem permeat, ac ex humiliori effluit similiter iisdem diebus in altiorem cuniculum infunditur, & interjecto puteo defluit in humiliorem cuniculum atque ex eo emanat. Autumnali verò & hyberno tempore, contra in cuniculum vel puteum humiliorem intrat, & ex altiori exit: verum ea fluxionum Aeris mutatio in temperatis Regionibus fit in initio veris, & in fine Autumni: in frigidis autem, in fine veris & in in initio Autumni.* To which he adds that which is more remarkable; That the Air in both the mentioned times, before its wonted course come to be durably setled, uses to be for the space of a fortnight liable to frequent changes, sometimes flowing into the upper or higher groove or Drift, and sometimes into the lower, (and passing out at the other.) If this Observation constantly hold, though but in some deep Mines, it may hint some odd inquiries, about considerable and *Periodicall* changes in the Subterraneall parts of the Earth, or in the Air, or in Both; which though they have not yet been considered, deserve to

Sed Aer utroque tempore anteaquam cursum suum illum consuetum constanter teneat plerumque quatuordecem dierum spatio crebras habet mutationes, modò in altiorem puteum vel cuniculum influens, modò in humiliorem.

be so. I have endeavoured to learn whether any such thing has been observed in some deep Lead-mines, whence I have procured divers informations about other particulars. But a very observing Person, that had the chief hand in contriving the *Subterraneall* structures there, assured me that both VVinter and *Summer*, the current of Air went constantly the same way: the Air entring in at the Mouth of the *Air-shaft*, and coming out at the *Perpendicular Groove*, which takes its denomination from a *Cave*, (or *Casa Putealis*) usually built over the Orifice of it, to shelter the Workmen from rain, and other inconveniences.

And since the writing of this, I found in *Morinus* (his Relation already mentioned) a passage that may somewhat illustrate the darkly exprest Observation of *Agricola*. For the lately mention'd Author writes, that in the deep *Hungarian* Mines he visited, the outward Air passed (first) through the Burrows, and so through By-waies, (if I may so call them) that tended not directly downwards, reacht at length to the bottom of the VVell, or perpendicular Groove, whence, together with the *Steams* proceeding from the Mine) is ascended strait upwards. But *Morinus* taking no notice at all of *Agricola's* Observation about the differing course of the *Subterraneall* Air at differing *Seasons* of the year: *though* (as I find by what he writes elsewhere,) 'twas Summer when he visited the Mines, and so what he reports,

reports, agrees well with one part of what *Agricola* seems to say; *yet*, as to the other, and principall part of his Observation, he says not any thing. And the sensible heat he ascribes to the steams ascending out of the perpendicular Well, leaves it somewhat dubious, what interest the Rarefaction of the Air, by the Subterraneous Heat may have in the *Phænomena* we have been discoursing of.

But to return to what I was saying before I had occasion to mention *Morinus*. Which perhaps it will not be impertinent to add, that I learn'd by inquiry, that the *Air-shafts*, and the Wells, were in these Mines much of a depth. But I hope ere long to have accounts of what happens in other mines, in other parts of England, as to the course of the Subterraneall Air especially when its issuing out of the Well, or the *Air-shaft* depend not on the changes of the Winds that blow above ground: And I wish the curious would employ the like endeavours in other Countries.

For indeed what I have hitherto discoursed in this Treatise, is *accommodated* but to the scant Information I have hitherto receiv'd; and therefore ought to be *rectified* or *Confirmed* by farther Informations if they can be procur'd.

In the mean time, I think I may probably enough, gather from the past Discourse, that though in some Mines, three Subterraneall Regions, and their distinguishing Attributes, may be

be not inconveniently assigned; yet generally speaking of the whole Body of the Terrestriall Globe (as farr as we know it) both the Bounds and the Temperature of the Regions of the Earth, as well as those of the Air, are various and uncertain enough.

And much less have we any certain knowledge of the Temperature of the more inward, and (if I may so speak) the more Centrall parts of the Earth; in which, whether there be not a continued solidity, or great Tracts of Fluid matter, and whether or no, differing Regions are to be distinguished, and what their number, Order, thickness, and qualifications may be, we are as yet ignorant, and shall I fear long continue so, For it is to be noted (with which observation I shall conclude) that what has been hitherto discoursed, belongs only to the Temper of those *S*ubterraneall parts, to which men have been enabled to reach by Digging. 'Tis true indeed that some Mines especially in Germany, and Hungary are of a *S*tupendious depth, in comparison of the generality of ours, and of the more obvious Cavities of the Earth; yet I find it boasted in a Discourse written purposely of the Various Mines, in the VVorld, that the rich Mine at *S*ueberg is 400 yards deep: And they are scarce believed, that relate one Hungarian-Mine which they visited to be 400 fathom; which though double the depth of the former, reaches not to half a mile. But the deepest of all the mines that I have as yet read or heard of, from any credible

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dible Relator, is that which the experienced *Agricola* in the Tract he calls *Bermannus*, *Cap.* 12. mentions to be at *Cotteberg*. But this it self though it reach to above 500 fathom, that is, 3000 foot, yet this prodigious depth dos not much exceed halfe a mile & fals short of three quarters; and how small a part is that of the whole depth of the Terrestriall Globe? whose semidiameter, if we admit the recent account of the Learned *Gassendus*, reckoned at 4177. Italian miles: in comparison of which, (as I was saying,) how small a thing is a depth that falls very short of a single mile?

Licet variæ de ambitu terræ opiniones sint, nobis tamen propemodum constet, esse ipsam milliarum Italiarum 26255, *quod in maximo ad Terræ superficiem circulo respondeant uni gradui milliaria proximè 73. &c. Gassend. Instit. Astronom. Lib: 2. Cap.* 13.

FINIS.

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